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CLASS ROOM DEVICES IN TEACHING ALGEBRA AND GEOMETRY.

BY JOSEPH A. NYBERG,

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Before a carpenter inserts a screw into a piece of wood he rubs soap on the threads of the screw. This is one of the tricks of his trade, learned as an apprentice from his master and not found in any textbook. No newspaper is considered up-to-date without a column of "Hints for the Busy Housewife," telling how to remove ink stains or how to make furniture polish. Every teacher likewise knows a few tricks from which we all could profit. The present article deals with a few devices, not mentioned in the texts on pedagogy, which I have found useful in teaching algebra and geometry.

1. The first device I call "Showing Successive Stages of the Work." The idea for it was obtained from First Year Mathematics by Marsh and Evans, page 52, where the method is used in multiplying two approximate numbers. The figure below shows what has been written on the blackboard when the method is used to teach long division in algebra. The significant feature is that each successive step is shown separately. Steps 3, 4 are here shown below steps 1, 2 but in the classroom the blackboard is usually large enough to permit all the steps to be written alongside of each other.

1. $$\begin{array}{rl} & 3x \\ 2x-5\,) & \overline{6x^2-7x+15} \end{array}$$

2. $$\begin{array}{rl} & 3x \\ 2x-5\,) & \overline{6x^2-7x+15} \\ & 6x^2-15x \end{array}$$

3. $$\begin{array}{rl} & 3x \\ 2x-5\,) & \overline{6x^2-7x+15} \\ & \underline{6x^2-15x} \\ & \qquad 8x \end{array}$$

4. $$\begin{array}{rl} & 3x \\ 2x-5\,) & \overline{6x^2-7x+15} \\ & \underline{6x^2-15x} \\ & \qquad 8x+15 \end{array}$$

5. $$\begin{array}{r|l} & 3x+4 \\ \hline 2x-5 & 6x^2-7x+15 \\ & \underline{6x^2-15x} \\ & \quad 8x+15 \\ & \quad 8x-20 \end{array}$$

6. $$\begin{array}{r|l} & 3x+4 \\ \hline 2x-5 & 6x^2-7x+15 \\ & \underline{6x^2-15x} \\ & \quad 8x+15 \\ & \quad \underline{8x-20} \\ & \qquad +35 \end{array}$$

To show how the method is used let us suppose I am dividing $6x^2-7x+15$ by $2x-5$. By comparing the work with arithmetic we see that $6x^2 \div 2x$, or $3x$, is the first term of the quotient. Hence I write on the blackboard

$$\begin{array}{r|l} & 3x \\ \hline 2x-5 & 6x^2-7x+15 \end{array}$$

While I am next making some general remarks or answering some questions I make a copy on the board of what I have already written there. Then when I multiply $2x-5$ by $3x$, I write the product, $6x^2-15x$, in the second copy so that we have on the blackboard:

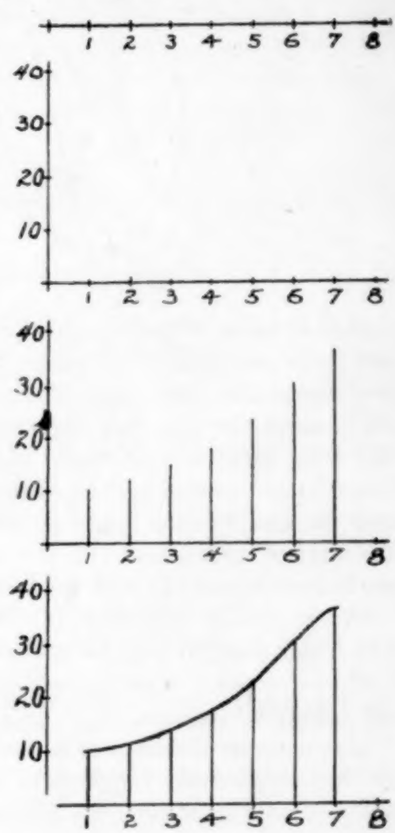
$$\begin{array}{r|l} & 3x \\ \hline 2x-5 & 6x^2-7x+15 \end{array} \qquad \begin{array}{r|l} & 3x \\ \hline 2x-5 & 6x^2-7x+15 \\ & 6x^2-15x \end{array}$$

Apparently, as if the idea had just occurred to me, I then ask the pupils to get out their papers and pencils and do on paper the same work that I am doing at the board. One reason for asking the pupils to do this is merely to give me time to make another copy of what I have already written. The next step is to subtract $6x^2-15x$ from $6x^2-7x$ and this subtraction is performed in my third copy, not in the second. Even when bringing down the $+15$ in the next step I do this in a new copy, not in the one in which the subtraction has been performed.

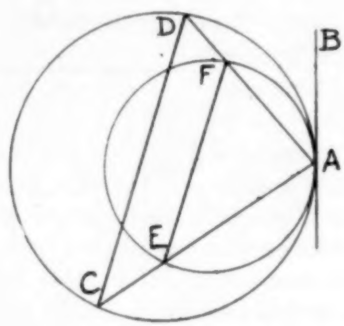
Thus when the division is completed we have on the board not merely the finished work but also a picture of each successive stage of the work. By looking at the blackboard, the pupil can see what happened first, what happened after the subtraction, etc., things that he can not see by looking at the last picture alone. Teachers frequently assume that they have the undivided attention of all the class when explaining any new process, but the attention of even the best pupil varies considerably. A pupil may understand one step of a process and not another step merely because his attention was momentarily distracted. The pupil then asks to have the process repeated. I find that such pupils can usually answer their own questions by looking at the successive stages of the work.

2. In teaching the construction of graphs this method is also very useful. The interpretation of a graph is so much easier than the construction that teachers have assumed that drawing graphs is subject matter suitable only for the less intelligent groups. Nevertheless, the mere selecting of proper units on the two axes calls for considerable good judgment and planning which are qualities that are found only in the more intelligent groups. I have never actually seen a pupil draw the graph first, and then draw the axes but I should not be surprised if a pupil were to do so. The frequency of the question, "What do you do first?" shows that the pupil does not grasp the successive stages of the work and can not learn them by looking at the finished picture. When solving an equation containing parentheses and fractions, there is no fixed order in which we must perform the operations. In drawing graphs, however, the steps are not interchangeable. Hence my method is as follows:

In a first picture I show only the horizontal axis with a scale clearly marked on it. Instead of adding a vertical scale to this picture, I draw the horizontal axis a second time and in this picture show both the horizontal and vertical axes. Again, on this picture I do not draw the vertical bars or plot any points as they are shown in the third picture. The fourth picture shows the graph. If the attention of one pupil was wandering when I was explaining the second step and the attention of another pupil was distracted at the third step, I do not need to repeat any of the explanations as the picture of each step is on the blackboard. Of course, every text contains rules but the ability to understand printed rules is not very common.



3. The work on graphs suggests that frequently in geometry also we may err by putting too much into one picture; the details may hide the main idea or the many lines may be distracting. In the figure below, for example, we are given the common tangent to two tangent circles and any two chords drawn through the point of tangency, and are to prove that CD and EF are parallel. This is a difficult exercise since the angle DAB is measured by half of either of two apparently unequal arcs, AF or AD. But most of the class is able to solve the problem (and incidentally learn something about the lengths of arcs) if the picture is presented as follows. After the picture has been drawn on the blackboard, I erase the smaller circle and ask the class to prove anything at all about the picture that they think might be useful. Each pupil writes down his own discoveries so that there is no ex-



change of ideas. Then I restore the smaller circle to the picture and erase the larger one, asking the pupils again to write down any discoveries they may make. Finally I erase the smaller circle again, leaving only the straight lines in the picture. By this time most of the pupils have overcome their difficulties. Even better results can be obtained by showing on the board four pictures, (1) the figure shown above, (2) the same but with the smaller circle erased, (3) the same as (1) but with the larger circle erased, and (4) with both circles erased.

Other similar exercises involving circles and tangents to which this method may be applied are:

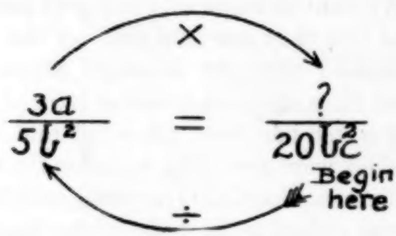
If two circles intersect, their common chord produced bisects the common tangents.

If two circles intersect in A and B and the two chords BD and BC are respectively tangents to the two circles, then AB is the mean proportional between AD and AC.

If two circles intersect and from a point P in the prolongation of the common chord two secants are drawn, one intersecting one of the circles in A and B and the other secant intersecting the other circle in C and D, then PA×PB = PC×PD.

4. Another and entirely different device I have found useful when changing a fraction to an equivalent fraction in exercises on addition. If we ask a pupil why $\frac{5}{9} = \frac{20}{36}$ he may answer that $20 = 5\times4$ and $36 = 9\times4$.

If we ask him to find the missing numerator in the relation $\frac{5}{9} = \frac{?}{36}$ and explain how he obtained it, he will surely say, "9 goes into 36 four times, and 5 times 4 is 20." The phrase *goes into* may be a useful one in the lower grades but in the ninth grade the word "explain" should mean a reference to the four fundamental operations of arithmetic. In the present illustration the pupil divides 36 by 9 and then multiplies 5 by the quotient.



In an exercise like $\frac{3a}{5b^2} = \frac{?}{20b^2c}$ the pupil should be conscious of the fact that he is to divide $20b^2c$ by $5b^2$ and multiply 3a by the quotient. To encourage this way of thinking I keep on the blackboard for some time the figure below.

The course of the arrow indicates the order in which we look at the different terms and the operations performed.

To train natives of Alaska in the use of small power boats so that they can earn their living by hunting seal, walrus, and whales, the United States Bureau of Education has fitted up the U. S. S. *Boxer* as a floating school. Navigation and wireless telegraph operation will be among the subjects of study. The *Boxer* is now used to carry teachers and supplies to the bureau's schools, reindeer stations, and hospitals in Alaska and to ship reindeer meat from Alaska to Seattle.

CHEMICAL THEORIES CONCERNING IONS AND ELECTRONS.[1]

By John H. Card,

English High School, Boston, Mass.

It seems rather hard to deal fully in a single hour with work which will be spread over a period of several days or weeks of actual teaching. Therefore this will be only an attempt to explain how I would endeavor to teach ions and electrons to a chemistry class of a secondary school but I hope to touch on the more important steps that will aid in the better understanding of elementary chemistry.

Preliminary Discussion

In actual practice the method used will depend largely upon the previous training of the pupils in the class, as seniors who have previously had physics and higher mathematics can be expected to deal more fully with the subject than juniors who have studied elementary science in their first year of high school only and have had little training in mathematics except arithmetic.

Method of Approach

Early in the course the action of sodium on water has been studied and many want to know why heat and energy are formed. As an answer to this they are told that for the present we will consider that the chemical action causes it and will take up more about it later. The electrolysis of water has been taken up and many questions asked were not fully explained. In the study of water of crystallization blue $CuSO_4$ crystals were heated to a white powder which was placed in the palm of the hand, after cooling, and a small amount of water added giving the original blue color and the evolution of so much heat that it was quickly dropped, the hand washed and much curiosity aroused asto why heat was formed.

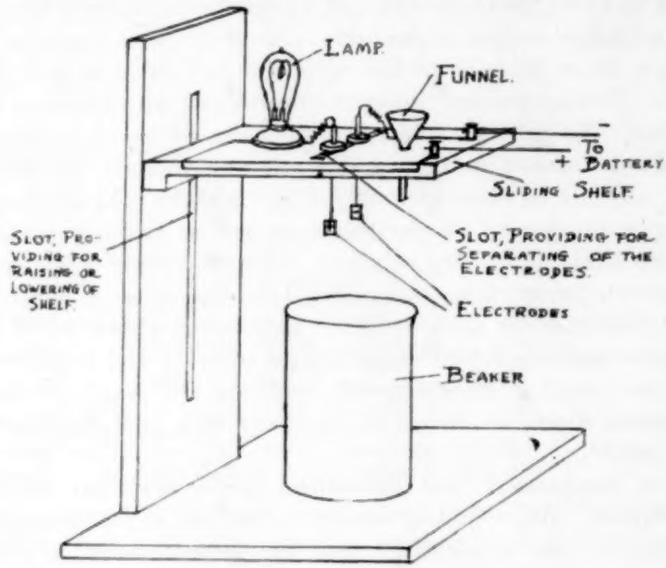
Often news articles of a scientific nature will create wholesome interest. With the study of solution in which color changes were associated with ions, so much curiosity has been aroused that it is deemed expedient to bring in the theory of ions as this seems necessary to explain many things. Therefore some time after Christmas we study the effect of an electric current on substances and solutions of substances.

In studying the effect of an electric current on substances and solutions of substances, an insulated copper wire conducts

[1]A paper given in Education SM6, N. Henry Black in charge, at Harvard summer school on July 27, 1923, by John H. Card, teacher of chemistry at Boston English high school.

the electricity from the plug to our apparatus. The electrolysis apparatus used was invented by C. H. Stone, teacher of chemistry at the Boston English high school, and drawings were made by Master C. M. Wright, a member of the senior class at the above school. An electric lamp is connected in series with platinum electrodes by insulated copper wire so that if any electricity passes between the electrodes it will cause the lamp to light. The lamp is used as resistance which protects from blowing any fuses, and the brightness

Experiment on Electrolytes and Nonelectrolytes



APPARATUS FOR STUDYING ELECTROLYTE AND NON-ELECTROLYTES.

with which the lamp glows indicates, roughly, how much electric current is passing between the electrodes; in other words how well the substance between the electrodes conducts the electric current. Electrodes are merely the ends of the wires by which the electricity enters or leaves the substance or liquid. The wire is insulated or covered with rubber, cloth, tar, etc., which holds in the electric current and will not let it escape except through the copper conductor touching another conductor. Thus we see that our circuit is made up of metals which are good conduc-

tors of electricity and nonmetals which are poor conductors or insulators. By touching the metal of a screwdriver to both electrodes you will notice that the lamp glows brightly and tells that the apparatus is properly connected.

The lamp and electrodes are on a movable shelf with a set screw to hold shelf at any desired height thus allowing the electrodes to be lowered into a beaker. An arrangement allows the distance between the electrodes to be varied. The funnel through the shelf allows one to add any liquid to the beaker containing the substance being tested. With this explanation of the apparatus let us lower the electrodes into a beaker containing some dry salt and record results in the table. In doing the demonstration the first three columns of the table are now filled in and discussed. During the discussion the fourth and fifth columns are supplied. To get salt solution, water can be poured through funnel into beaker containing dry salt and changes noticed in lamp; also notice effect of lowering and withdrawing electrodes slowly in solution of an electrolyte as well as varying distance between electrodes in the solution. Notice changes when some concentrated electrolyte (conc. $HC_2H_3O_2$) has water added to it while electrodes are in electrolyte. Substances are tested in the dry state and in solution using various solvents and nonelectrolytes are tested in their original condition and water solution. Electrodes should be rinsed off carefully with pure water after each test.

It is emphasized that substances in the dry state are not electrolytes. After adding water to salt in the beaker it is brought out and emphasized that the solvent must be water for a solution to be an electrolyte because when glycerine, etc., was added to salt no light was observed. (Liquid ammonia may act similar to water as a solvent.) Pure water will not conduct electricity while impure will, providing it contains an acid, base or salt. Water solutions of acids, bases, and salts are electrolytes and all other substances are nonelectrolytes. An electrolyte is a substance whose water solution will conduct an electric current and is permanently decomposed by the passage of the current. (Later it is taken up that some substances are electrolytes when fused.) A study of the table, page 353, shows that the lamp glowed brighter with some substances than with others and discussion brings out that those substances found in

Discussion of Experiment on Electrolytes and Nonelectrolytes

the laboratory to be most active chemically are the strongest electrolytes and that their chemical activity was generally studied in solutions with water where they would exist as ions. The conducting power of a solution varying with change of concentration shows varying number of ions and varying chemical activity. Solutions causing the light to glow brightest are the most active chemically and contain the most ions. Therefore

RESULTS OF STUDY OF ELECTROLYTES AND NON-ELECTROLYTES.

Solvent	*Solute*	*Lamp*	*Remarks*	*Ionic Formula*
None	Salt	No light	No ions	None when dry
None	Sugar	No light	No ions	None when dry
None	Starch	No light	No ions	None when dry
None	Glyc'rine	No light	Nonelectrolyte	None
None	Kerosene	No light	Nonelectrolyte	None
Kerosene	NaCl	No light	No ions	None
Glycerine	$CuSO_4$	No light	No ions	None
Alcohol	Sugar	No light	No ions	None
Water	None	No light	No ions	None
Water	Glyc'rine	No light	No ions	None
Water	Starch	No light	No ions	None
Water	H_2SO_4	Bright light	Many ions	$(H+)_2(SO_4)--$
Water	HNO_3	Bright light	Many ions	$H+NO_3-$
Water	HCl	Very bright	Very many ions	$H+Cl-$
Water	$HC_2H_3O_2$	Dim light	Few ions	$H+(C_2H_3O_2)-$
Water	NaOH	Very bright	Strong electrolyte	$Na+OH-$
Water	$Ca(OH)_2$	Medium	Medium electrolyte	$(Ca^{++}(\overline{OH})_2$
Water	NH_4OH	Dim light	Poor electrolyte	$(NH_4)+(OH)-$
Water	NaCl	Very bright	Very many ions	$Na+Cl-$
Water	$CuSO_4$	Bright light	Many ions; Deposit on cathode	$Cu++SO_4--$
Water	Na_2CO_3	Med'm light	Medium electrolyte	$(Na+)2CO_3--$
Water	$NaHCO_3$	Dim light	Weak electrolyte	$Na+H+CO_3--$
Water	$NaC_2H_3O_2$	Dim light	Weak electrolyte	$Na+(C_2H_3O_2)-$

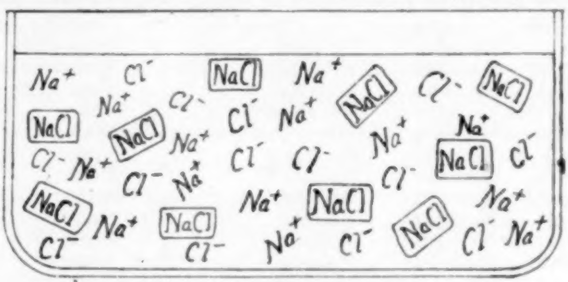
Bubbles were given off from electrodes in testing electrolytes.

chemical activity depends upon ions, takes place in solution between ions, and can be controlled by causing ions to leave the solution or field of action. (Liken to a football game when one team leaves the field and stops the game.) Because of ions leaving solution, chemical reactions will go to an end by volatility, precipitation, or non-ionization. Metals are positive, as are H and NH_4, non metals are negative and the number of positiveons always equals the number of negative ions that are formed by an electrolyte. The number of charges on an ion corresponds to the valence. The nearer together the electrodes and the larger surface of electrode in contact with the electrolyte the more electricity will pass. A deposit on an electrode (cathode) and bubbles indicate chemical change and suggests a project on electroplating.

How shall we explain the experiment on electrolytes and nonelectrolytes? A study of the boiling points of solutions

containing the gram molecular weights of substances in a liter of solution shows that nonelectrolytes in solution boil at about 100.52°C whereas similar solutions of electrolytes with two ions raise the boiling point almost twice as much. A similar study of freezing shows that solutions of nonelectrolytes freeze at about −1.86°C while electrolytes with two ions lower the freezing point about twice as much. The rate at which solutions of electrolytes pass through

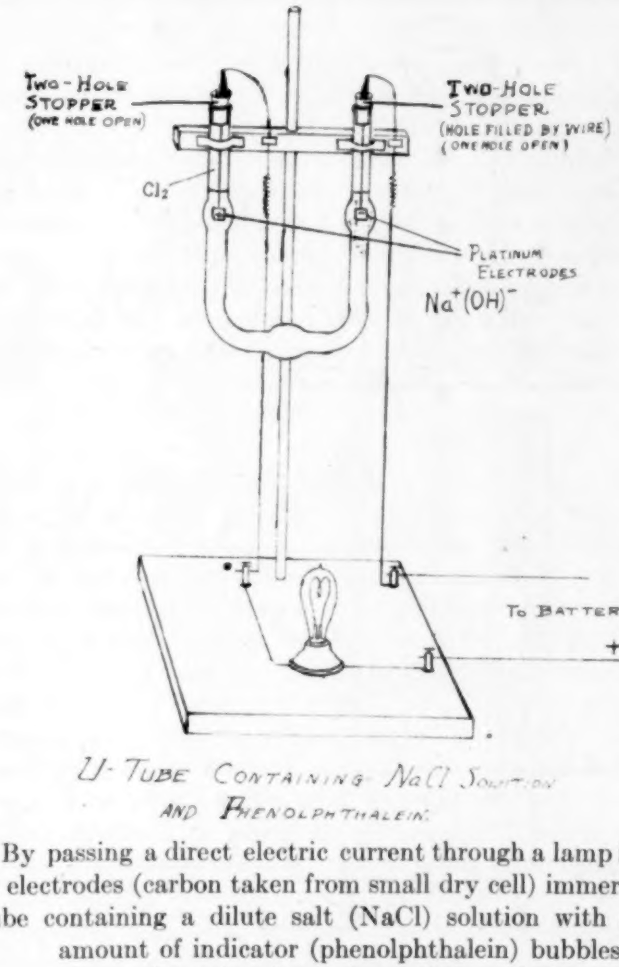
Ionic Theory



SOLUTION OF SALT

porous membranes and osmotic pressure are about twice as great as that of nonelectrolytes. Thus research work indicates that electrolytes in dilute solutions are dissociated into about twice as many particles as nonelectrolytes so it is considered that nonelectrolytes are in solutions as molecules and electrolytes of two ions exist as molecules as well as dissociating into ions. An ion is an atom or a radical carrying a number of electric charges that corresponds with its valence. Acids, bases, and salts dissociate into ions when they are dissolved in water. In the process of dissociating the metallic or hydrogen part loses one or more electrons, depending on valence, and the nonmetallic part acquires a similar number. The electrons are the smallest portion of negative electricity that can possibly exist and are estimated to have about 1/1800th the size of the hydrogen atom for each electron. Diluting the solution tends to make all molecules dissociate into ions and making the solution more concentrated increases molecules. We have already seen that the number of ions depends upon the solute and that the chemical activity varies directly with the number of ions. In an ordinary solution of an electrolyte there will be both molecules and ions which will be dissociating and forming, yet the total number of each will be constant. Thus dynamic equilibrium (moving equality) is the dissociating of molecules into ions and the com-

bining of ions to form molecules at equal rates so that the total number of each is always the same. The molecules and ions (wanderers) are moving indiscriminately throughout the solution until an electric current directs the movements of the ions.

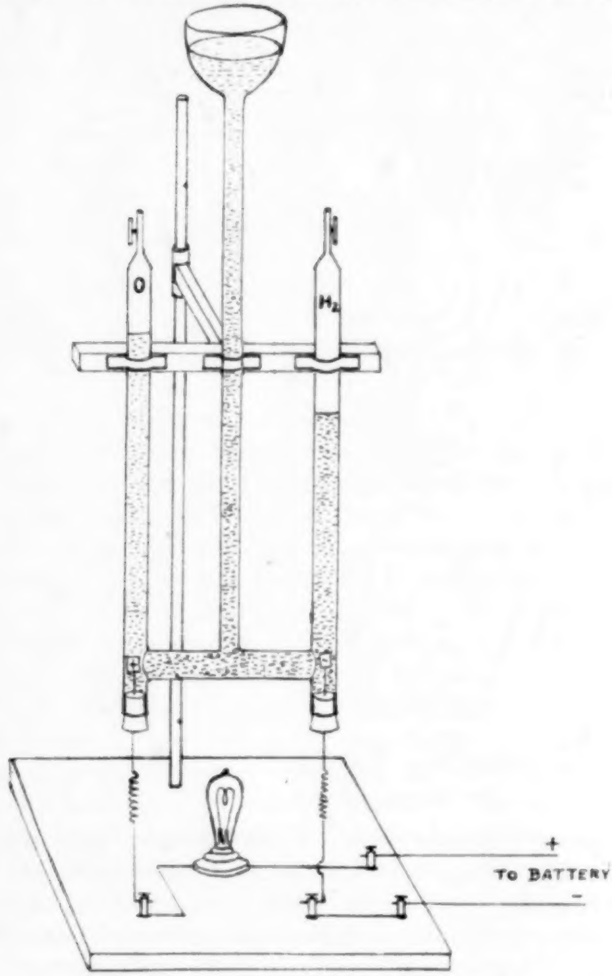


U-Tube Containing NaCl Solution and Phenolphthalein.

By passing a direct electric current through a lamp in series with electrodes (carbon taken from small dry cell) immersed in a U-tube containing a dilute salt (NaCl) solution with a small amount of indicator (phenolphthalein) bubbles will be given off at the electrodes and the solution turns red around the cathode. By reversing the current after a short time the red color will disappear and form at the other electrode, the new cathode. Discussion of this will bring out that the ions are formed when the salt is dissolved and have no definite arrangement in the solution but the electric current collects all of the positive ions at the cathode

Ions and Atoms

and all of the negative ions at the anode where the electric charge is neutralized (passes off through the wire) leaving the atoms which are active as such. Thus salt dissolves in water according to the equation $NaCl = Na^{+} + Cl^{-}$. Both molecules and ions are present which are constantly changing places in dynamic



ELECTROLYSIS OF WATER (HOFFMAN APPARATUS)

equilibrium. When the current passes Cl^{-} collect at the anode where Cl atoms and Cl_2 collect and Na^{+} collect at the cathode where Na atoms act on water to form Na^{+} $(OH)^{-}$ that turns phenolphthalein red: $2\,Na + 2H_2O \rightarrow 2\,Na^{+}OH^{-} - H_2$. Evapora-

tion of solution will form molecules. $2Cl_2+2H_2O \rightarrow 4HCl+O_2$. Ions are atoms or radicals carrying one or more charges of electricity according to their valence and have entirely different properties from atoms. The neutralization may be indicated by the equation $H^+Cl^- + Na\ (\overline{OH}) \rightarrow Na^+Cl^- + H_2O$.

The electrolysis of water should now be better understood if it is explained how ions of H_2SO_4 aid the process. The valence table of the elements can now be changed substituting pluses and minuses for the numerals. Equations of chemical reactions already studied should be reviewed and written indicating ions wherever possible and further drill in writing ionic equations should be given. Acids are now defined as being substances whose water solution contains the hydrogen ion which can be replaced by a metal, turns blue litmus red, can react with a base to form a salt and undissociated water and have a sour taste. Bases are defined as substances whose water solution contain the $(OH)^-$, turn red litmus blue, react with acids to form salts and undissociated water. Salts, acid salts, basic salt, neutralization, hydrolysis, etc., can now be explained in terms of ions. The fact that H^+& $(OH)^-$form molecules of undissociated water in neutralization with the liberation of 13,790 calories per gram molecular weight of water may be brought out. Hydrolysis of salts from a strong acid and a weak base give acid reaction due to excess H^+ over $(OH)^-$ whereas salts of strong base and a weak acid give basic reaction in solution shown by $CuSO_4$, $Al_2(SO_4)_3$, Na_2CO_3, $NaHCO_3$, etc., with applications. Na_2CO_3 being strongly basic in solution is used in washing powders, etc. and $NaHCO_3$ is used extensively in cooking and medicine on account of its basic reaction. From now on ions are talked of wherever applicable. Projects on electroplating, storage battery, etc., often prove interesting.

Applications of Ionic Theory

Experiments developed by C. H. Stone dealing with ions are appended. In writing up these experiments complete sentences and correct English should be required.

Exp. 12. Water of crystalization. Name..............................

Save all products from part A.

A. Put into separate dry tubes about 5/10 gram (size of a pea) of each crystal substance named below. Heat each substance gently, holding tube over the flame, not in it. Keep open end of tube slightly lower than the heated end. Continue the heating till nothing more happens. Do not mistake melted substance for water.

Substance Used	Amount of Water (Much or None)	Change in Appearance of Crystals
Blue vitriol		
Copperas		
Alum		
Saltpeter		
Galena		

Is there water of crystallization in all crystals?..

With filter paper dry the inside of tube containing the residue of the blue vitriol. Pour out the cold solid into palm of hand, powder it in hand, and add two drops water to the powder in the hand.
State results..
When this substance had its water driven out, heat was the agent. How do you explain this present change in energy?..

Why should the tubes be held with open end slightly the lower when heating them?..
If the crystals were heated too hot, what else might happen to them besides driving out the water?..
To what are the color and shape of many crystals due?..

Is the liquid obtained by heating saltpeter, water? How do you know?

B. At side desk note the scale with sodium sulphate crystals, also the one with calcium chloride crystals. Both scales were in exact balance when placed at side desk. Explain any weight changes noted..

Define the words that name the properties shown in B..

Exp. 17. Study of ionization. Name..
Note the colors of solutions on side shelves of: lead nitrate, copper nitrate, nickel nitrate, potassium bromide, Barium chloride, cobalt chloride, potassium permanganate, potassium bichromate, zinc sulphate. Make a solution of copper bichromate: ($Cu(NO_3)_2$ plus a few drops $K_2Cr_2O_7$).

+ ions	− ion	color	colored ions	colorless ions
Cu	Cr_2O_7			

In all cases, to what ions is the color due?..

Relation of water to crystal color. In a dry tube held level heat, over a flame not in it, a little (5/10 g.) copper chloride crystals. Keep tube level and remove all moisture with filter paper. Note the color change..

Transfer half the residue to another dry tube. To one tube add a few drops benzol; to the other add a few drops water. State results..

Explain results..
Precipitation of colored ion. Note color of nickel nitrate solution. Treat

10 cc. nickel nitrate with excess sodium sulphide solution. **Let stand.** What happens? Why does color disappear?..

....

Decomposition of colored ion. Make a solution of sodium **bisulphite** (1 g.) in water. Add this to a tube one-third full of potassium **permanganate** solution. What happens? Why?..

....

Exp. 18. General properties of acids and bases. Name..............................
Acids. Test dilute solutions of hydrochloric, sulphuric, boric, and acetic acids in separate clean tubes for taste and action on litmus paper and methyl orange. Touch the paper with a drop of each acid on tip of stirring rod, washing rod after each trial. For tasting, use a few drops of acid with five to ten drops water. Do not swallow the acid. Save all tubes for later use, in which are the methyl orange.

Acid Formula + ion	– ion	Physical state	Taste	Litmus turns from	Methyl orange turns from
				to	to
H_3	PO_4				

General Conclusions..

....

Bases. Test in same way dilute solutions of sodium, potassium, barium and ammonium hydroxides in separate clean tubes. Use the methyl orange solutions left over from above. For example, to the tube containing hydrochloric acid and methyl orange, add sodium hydroxide.

Base Formula + ion	– ion	Taste	Feel	Litmus turns from	Methyl orange turns from
				to	to
Ca	$(OH)_2$				

General conclusions..

....

How do you account for the similarity in acids?..

....

Why do all bases have very similar properties?..

....

References.

For an excellent treatment of ionization and allied topics see, "The Electrolytic Dissociation Theory," Talbot and Blanchard; Macmillan.

For treatment of the applications of electro-chemistry to experimental work see: "Experimental Electro-chemistry," Hopkins; Van Nostrand; "Practical Electro-chemistry," Blount; Macmillan; "Practical Methods of Electro-chemistry," F. Mollwo Perkin; Van Nostrand.

One of the older texts is "Textbook of Electro-chemistry," by Le Blanc; Macmillan.

Valuable material may be found in the following books:

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Watts, Oliver P., "Laboratory Course in Electro-chemistry"; Van Nostrand.

BLOOD CELLS HURT BY RAYS OF RADIUM.

Exposure to radium radiation for a few hours daily over a long period has apparently been shown to be dangerous to health, says a report of the U. S. Public Health Service. The blood seems to be especially affected showing a reduction in the number of both red and the white corpuscles. Blood pressure becomes abnormally low.

These conclusions follow a study made of workers at the U. S. Bureau of Standards who handle radium daily and are exposed to its effects. Practically all the radium sold for medical or scientific purposes in the United States is sent to the Bureau of Standards for measurement. Twelve of the employes of this radium section, five men and seven women, were studied over a period of months. All but two had handled radium for at least six months previous to the beginning of the test. One had been out of the radium section for a year and a half, but before that had been in it for more than six years.

The fact that the employes were exposed to radiation in spite of precautions taken to prevent the rays striking their bodies was demonstrated by the use of sensitive films such as are used for taking dental X-ray pictures. These were worn by the men and women for several days and when developed showed unmistakable evidence of exposure to radiation. The principal areas of exposure were the head, arms, and hands.

The probable reason for the effect of the rays from radium on the blood, while X-rays have no such influence, is stated to be that the more penetrating gamma rays of the radium affect the bone marrow, which is known to be the source of the blood cells. While none of the workers observed was invalided during the period of the test, one had just recovered from an illness diagnosed as anemia and showed fewer blood corpuscles than normal, both red and white. Practically all the others showed a tendency to diminution of the blood corpuscles especially of the white ones, which are those concerned largely with immunity from and resistance to disease.

Blood pressure was below normal in practically all the workers during the whole time of the study.

As a result of these findings it is recommended that workers in radium should be protected as far as possible by the use of metal screens opaque to the rays; that they should be subjected to frequent physical examinations; that they should not be permitted to work more than five days a week with at least a two day period intervening between the two rest days; and that they should have vacations of two weeks, taken at six months intervals, and spent as largely as possible out of doors. Further investigations are in progress.—[*Science Service.*

WHAT ARE WE *TEACHING* IN CHEMISTRY?

By Henry L. Gerry,

Lewiston, Maine.

One sometimes wonders what the effectiveness of his teaching really is. This is not always easy to determine, especially when one examines his own students with questions set in phraseology familiar to them and based upon materials that have been used for drill. Furthermore, although teachers try to set objective written tests they become acquainted with peculiarities in handwriting, so that subjective impressions of a student's intentions often color the final judgment of his attainments. A true measure of effectiveness might perhaps be secured if we should set up very definite and specific aims and if we should devise means of measuring accurately how nearly each student comes to reaching our objectives. Lacking these, it may be interesting to look at the problem from another angle and to see some of the inappropriate answers that have been written to simple test questions.

Recently, in conducting an investigation looking toward the construction of simple standardized tests in chemistry,[1] the writer secured answers to one hundred questions about chemistry from a large number of boys and girls who were just completing a year of chemistry study in American secondary schools. The questions were derived from those formulated by committees of specialists. The particular committees here concerned were those engaged in preparing and reviewing questions for the college entrance examination board. In the derivation of the questions an analysis was made of the eighteen general and comprehensive examinations set between 1911 and 1920 by the committees co-operating with this board from year to year. This analysis showed, as has already been pointed out in this journal[2], the frequent recurrence of certain topics in the examinations. These were checked by four commonly used textbooks in general chemistry to substantiate the judgment of the committees by that of other specialists in the field of chemistry. It is reasonably certain, therefore, that the items included in these questions cover topics ordinarily taught to classes of chemistry students in secondary schools. All the students were unknown to the writer, so that a judgment of their information about chemistry had to

[1]Editor's note: Dr. Gerry's tests are published by the Harvard University Press, Cambridge, Massachusetts.

[2]Gerry, H. L., College Entrance Examination Board Questions in Chemistry, School Science and Mathematics, Vol. 20, pp. 845-850.

be reached from the answers that were actually written. A subjective impression of the student's intentions was not allowed to influence a judgment of his attainments. It was very evident from an examination of the answers that some students had not learned what the teacher probably thought had been taught. It is the purpose of this paper to point out some of these examples of misinformation with the hope that teachers may be more wary of assuming that a thing has been taught when it has simply been presented to the class.[3]

In some kinds of standard tests it is necessary to have some questions so easy that nearly everyone, for whom the test is appropriate, will be able to give correct answers. It would seem that a question concerning the components of pure water would be so easy that practically all students with a year's experience in chemistry would be able to answer it correctly. In fact, many adolescent boys and girls who have never studied chemistry have learned from their everyday experiences the answer to this question. As a matter of experience, about ninety-seven per cent of the students who were asked this question could tell what these elements are. That some should be confused by a new type of test and write "oxygen and nitrogen" as the components of pure water, it is easy to conceive. On the other hand, that one should write "h_2 and o_2" seems to be evidence of careless instruction. A single instance of this sort might be attributed to carelessness on the part of the examinee but when the error recurs on other papers with other symbols, such as "cl, p (for potassium) and ba," must we not charge the science teacher with carelessness? With this question of the components of pure water there was one other type of error that went far afield. To account for this is more difficult. How can one explain, for example, the mental process of the lad who maintained that pure water is composed of iron and rain?

Other questions that apparently involved only simple and elementary information were the source of erroneous responses. For example, the number of cubic centimeters said to make up a liter varied from 0.09 to 100,000. Other values given were 1, 1.09, 1.24, 10, 12, 13.2, 20, 22.2, 22.4, 22.5, 22.7, 23, 23.7, 24, 24.4, 30.4, 37.9, 100, 115, 120, 144, 160, 210, 225, 244, 273, 500, and 22,400. It is easy to see where some of these numbers came from; to understand how other constants were confused with the one required. The source of other values is a more baffling problem. One explanation of the error may be that teachers did not

[3]Cf. Scott, F. and Myers, G. C., Children's Empty and Erroneous Concepts of The Commonplace, Journal of Educational Research, Vol. 8 (1923), pp. 327-334.

intend the fact to be mastered. Again, one might reasonably expect a student with a year's experience in chemistry to say that every metallic oxide is a compound of a metal and oxygen. Many did so; yet some thought "acid and a base, metal and base, metal and carbon dioxide, hydrogen and acid, or hydrogen and oxygen," satisfactory answers to the question. Had the teacher, in these cases, assumed that so simple a concept had been grasped on its first presentation and retained without review?

Evidence gathered from the testing tends to show that some students are not at all sure of chemical terminology. For example, the copper salt of nitric acid is called copper sulfate, cupric acid, copper hydroxide, and common cooking salt; the sodium salt of permanganic acid is called sodium chloride, sodium sulfide, sodium sulfate, sodium hydroxide, and potassium chlorate; and the sodium salt of hydrobromic acid is called sodium hydrobromate and seltzer. An oral recitation, with occasional help and correction from the teacher, might not so badly reveal these deficiencies. In conversation, where endings are elided and words clipped, such a pupil might appear to have a considerable knowledge of chemistry. In many cases, however, scientific accuracy in terminology would be lacking. With such loose expression can there be anything but loose thinking? Can we not, as teachers, teach more thoroughly the fundamental working tools of a chemist and, in this connection, require greater precision in the use of endings?

The examples just cited make one think that the teacher did not see to it that various types of imagery were used in the learning. In many cases it would seem that auditory imagery was relied on exclusively, that visual and kinaesthetic[4] imagery had played no part in the learning. If this is not true how may one explain such expressions as solvate, sociated, matter's indistrouble, cordon dioxide, Malcom and algemand (for amalgam), hydrant, ellorquescent, atopothis (probably intended for amorphous), anydrious, moinlitic and nomenclinic (for monoclinic), morphus, orthographic, and argothropic? Absence of a clear image also might account for naming inert gases crpton, heoxilin, neolin, nipon, xnephon, and zenorym.

Among the answers there were to be found, also, misspellings of common words. Must chemistry teachers accept slovenly English or may they demand as high a grade of work as that de-

[4]In the learning process, one commonly thinks of kinaesthetic images as those having to do with writing or with other manual operations. One should remember also that images of tracheal muscular changes in speaking and reading are also kinaesthetic.

manded in corresponding classes in English? Should not chemistry teachers and teachers in all other fields of study, for that matter, cooperate with the English teachers in an effort to eradicate from the written work of high school juniors and seniors such crudities as oxegyn, gass, zinck, mettle, evervesent, and ballons.

Students showed woeful difficulties not only in spelling English words but also in using chemical notation. Attention has already been directed to the use of h, o, cl, p, and ba. Further samples of a similar sort are Co_2 for carbon dioxide, KpO_4 for potassium hypochlorite, Mg for manganese, $PlPa_2$ for plaster of Paris, Oz and Os for ozone, and Fr for fluorine. Other misconceptions of the use of symbols, in chemical combinations, are shown by formulas such as Na_3Al, $FeCl_4$, and KSO_4. Is not the symbolic representation of chemical substances fundamental to an intelligent study of chemistry as it is usually written and as it is usually taught? Must we not make sure, then, that our students are firmly grounded in these fundamentals?

An examination of the test papers revealed, further, difficulties with numerical problems and difficulties with equations. The former are passed over. To illustrate the errors, ranging from errors in simple arithmetic to errors in the analysis of the requirements of the problem, would use more space than is warranted here. Perhaps most teachers of chemistry detect errors of these sorts in their own classes. In considering the latter difficulty it would seem as if the principles of equation writing might be taught so that every student, after a year of study, would be able to write the equation for the reaction between sodium and water. How can we allow a pupil to reach the end of the school year if he will write $Na+H_2O = Na_2OH$ or $Na+H_2O = H_2Na + O_2$, or if he will write an equation for the preparation of oxygen as follows: $2K+2H_2O = 2KOH+O_2$? If some of our pupils make these errors do we not need to explain again to them the principles of equation writing and give them drill in the process? Drill of this sort is carried on successfully without appreciable loss of time from the recitation by mimeographing a series of incomplete or skeleton equations and passing them out in groups of five or ten to each pupil as the class is assembling. The class begin to complete the equations as soon as they take their seats and the teacher is thus given an opportunity to check attendance without halting the work of the class. When sufficient time has been given, the papers may be collected, the completed equations written on the board by a student or at

a student's dictation, troublesome points elucidated, and the previous day's equations reviewed. In this way students' errors and misapprehensions may be discovered and corrected before they have become fixed. Finally, it may be well to return the papers of the day before, with errors marked, and require that the wrong equations be corrected and returned. A set of two or three hundred equations, carefully selected to illustrate different principles in equation writing, will serve a class for a year by using them over and over in different combinations.

Practical laboratory work seems not always to have fixed in the minds of pupils the practical methods of operation. The laboratory preparation of oxygen is often carried out by pupils in general science; almost always by students of chemistry. What shall we say for the high school senior who believes, after studying chemistry for a year, that to make oxygen one should "put iron in a test tube over night"? Effective laboratory teaching is one of the most arduous tasks that a teacher is asked to undertake. Too many of us provide a manual, the apparatus, and the chemicals, and expect the laboratory to run itself. The teacher who makes the most of his laboratory and who by practical work fixes chemical principles does not do this. He visits his pupils, talks over with them the work that they are doing, questions them on the particular experiment in hand and on other related materials; in short, he tries to help his students associate the new experience with that which is familiar.

By way of diversion, a few glaring errors may be pointed out. One finds in the answer papers that the gas that escapes from freshly drawn soda water is either hydrogen, phosphorus, sodium, nitric acid, carbon disulfide, or sodium hydroxide gas; that galvanized iron is iron covered with a thin layer of copper, potassium, carbon, sulfur dioxide, paint, rust, or agate; that the substance that burns with a blue flame at the top of a coal fire is aluminium, sulfur dioxide, carbon dioxide, oxygen, copper, nitrogen or carbon disulfide; that hypotheses are statements of facts. Furthermore, one learns that when a solution contains all of a given solute which it can hold at that temperature it is said to be normal, colloid, a compound, or solutionalized; that the most abundant two components of the atmosphere are hydrogen and oxygen, carbon monoxide and carbon dioxide, or oxygen and silicon; that aqua regia is made from gold and some other substance such as hydrochloric acid, nitric acid, or water; that aluminium in $Al_2(SO_4)_3$ has a valence of 328; that a neutral solu-

tion of sodium bicarbonate contains Na^+ and NO_3^- ions; that arsenic is put in lead shot to make them explode, stick together, smokeless, or kill insects; and that chlorine is used as a "deadening gass."

Although this seems a wide range of errors it is a satisfaction to report that they were not commonly made. That they should have been made at all is a pity. Although you chemistry teachers may have smiled as you read some of these errors, such an array of needless ones should make us examine our jobs more critically to see if we are leaving untried any method or device that would help to produce more creditable results.

HIGH FIFTH MATHEMATICS—PROJECTS TESTED IN TEACHING DENOMINATE NUMBERS.

By Jenny Lind Green,

Supervisor of Grammar Grades and Teachers of High Fifth Mathematics, San Antonio, Texas.

A. *Questions governing the selection and teaching of these projects.*

Questions governing selection of projects:

1. Was there an actual need for carrying out the project? Was that need such that the children were legitimately interested in it?
2. Did each project involve some essential phase of needed mathematics?
3. Was the mathematics involved in these projects adapted to the particular needs of the grade?
4. Were the other factos involved in the projects such that the children could understand them without too great waste of energy?

As regards selection of groups of projects:

1. Was the group selected such that all essential phases of the work were represented?
2. Was the selection such that more important phases received due emphasis?
3. Was the order of use of projects such that the children had or could get without too great difficulty, the necessary information and ability to do the mathematics work involved in the new project? (In other words, were the projects graded in order of difficulty to the extent that progress could be made?)
4. Was the order of selection such that it took account of the interest in and need for the project being performed at a particular time? (In other words, if a party was being given and the problem of what refreshments could be used, and mathematics in connection arose, was the project used at a time when it would actually be of service to others?)

Questions governing teaching of projects:

1. Were the children conscious of the need for carrying out the project?
2. Did the children take as much responsibility as they could profitably in planning and organizing the work on it?
3. Were essential facts and processes of mathematics involved in these projects emphasized in carrying them out?
4. Was review work tested systematically, and drill on it carried on systematically and in such a manner that it raised standards of method and accuracy?

5. Was the method of work such that *each* child profited by it?

6. Was the method of work such that it helped develop ability to *see* practical mathematics problems, and isolate the mathematical factors from the social factors?

B. *List of Projects;*

1. Buying materials for the school.
2. Determining where to place playground apparatus.
3. Calculating amount of play space per pupil?
4. Determining whether the room is too crowded by estimating amount of air per pupil.
5. Weighing and measuring the children in order to find out whether any are over or under weight.
6. Planning where a new school building should be placed.
7. Laying off a baseball diamond.
8. Planning where shrubbery, trees, etc., for school ground decoration should be placed.
9. Making book covers.
10. Running a real store.
11. Keeping account of cafeteria supplies and costs.
12. Making a window box for the principal's office or for the schoolroom.
13. Buying and making curtains.
14. Planning and carrying out improvements in the school-rooms. (For example, rearranging furniture of library with a view to spacing and light, etc.)
15. Staining a floor in the teacher's rest room.
16. Placing pictures.
17. Placing shrubbery, flower and vegetable gardens, trees, etc. on the home lots.
18. Placing furniture at home.
19. Determining size of rugs to be bought for rooms of stated sizes, etc.
20. Reading gas and water meters.
21. Calculating fuel bills (wood used here mostly.)
22. Buying linoleum for the bathroom and kitchen.
23. Screening the house. Repairing screens.
24. Building chicken coops and bird houses.
25. Determining relative costs of different menus.
26. Calculating saving by wholesale buying.
27. Finding out how much more expensive lots with paving and walks should be than lots similarly located without walks and paving.
28. Making a book of measures for reference in class and home work.
29. Investigating the interesting history of our units of measure.
30. Making tests, drills, etc., for groups of children after studying their needs.
31. Making a book of practical problems.
32. Finding out if it pays to keep chickens in San Antonio.
33. Finding out under what condition it pays to keep a cow.
34. Graphing test results of the class or the individual children.
35. Calculating costs of telegrams.
36. Calculating milk bills.
37. Keeping home accounts for other supplies.
38. Making a clothing budget.

C. *Comments on origin of and important factors involved in certain of these projects;*

The projects involving placing of shrubbery, trees, gardens, buildings, etc., arose in connection with a campaign for clean-up and beautification. This campaign was a teaching campaign

lasting throughout the year, and receiving during the various seasons such emphasis as the seasonal differences and civic developments necessitated. Each child worked on what needs arose in his own experience, what seemed common in the experience of people, and what he could do to help his classmates in their problems. To illustrate:

A Mexican girl told her classmates that a truck smashed through a panel of fence around their home lot. She held the new panel straight while her father fastened it. The children found that nearly all of them in that district had fences, told numerous incidents illustrating the frequency of repairs needed decided that they should know how to estimate cost of fencing for their homes and worked on the problem.

One school found that it had room for a garden at school. They placed their garden, bought seeds, raised vegetables, marketed them, and kept accounts. This was a problem of common interest. All worked on it and learned practical measures, accounts and management which led to many other measure problems.

The report by children of home plans or needs for beautification led to scale drawings showing the home or lot, the house and other buildings, shrubbery, trees, etc., already on the lot, and general discussion by the class of what else was needed, where to place it, and how to grow it. A thorough acquaintance with the units of long measure, in their relation to one another, practical use of them in the various problems of reduction and fundamental operations involved in the work.

One family was buying a lot. The problem arose, "How much more expensive should a lot with walks and paving be than one similar in other respects, but without walks and paving?" This involved examining real estate news in the papers relating this to the city map, finding out how walks and paving are built, units of measure, etc., and drawing a lot to scale, placing walks and paving and estimating the costs.

A school needed window box and curtains for one room. The class studying denominate numbers took it for their problem. They measured the windows to find dimensions for the box and amount of material needed for box and curtains. They bought lumber and scrim, testing the samples of scrim before buying, and made both box and curtains following with related study of what plants to buy for it and how to care for them. They received practical training in use of long measure and

lumber measure. This led to many other related mathematics problems.

Another group of problems developed from a campaign for money to build more buildings and repair old ones. The children helped survey the needs of the schools, showing how much play space they had, comparing with the amount considered necessary for schools and deciding where in their opinion new buildings and additions should be placed.

Still another type of problem arose in connection with health problems. Groups of fifth grade children weighed and measured children in the school to ascertain whether they were under or over weight.

The book of measures made for reference use during the term began with the first problem they met in this work and continued in construction throughout the term. It included results of a survey of how things they use are measured when bought and sold, and it contained pictures of these things with the proper units of measure. Tables of measures were added as they needed them. Home problems were also included. Since they varied for each child, taken together they made an interesting collection of supplementary problems. The text was used to supplement these.

The research for history of measures developed research method and made for greater interest in the study of denominate numbers.

C. *Types of work;*

1. Investigation—

Trips to the stores and inquiry at home to find out how things are measured and how bills for them are computed; reading newspapers for market reports, etc.; observing construction of walks, paving, building, repairing, etc.; reading for history of measures and for mathematics facts.

2. Construction—

Repairing, building bird houses, window box, making curtains, screening, operating a store, making scale drawings, books, making budgets, making gardens, etc.

3. Testing—

Testing ability as regards concrete and abstract problems, both for method and accuracy.

4. Drill—

This was determined by the results of tests; teachers and children working together to determine shortcomings and drills needed.

BIOLOGICAL COURSES SPONSORED BY CASS TECHNICAL HIGH SCIENCE GROUP.

By Clara E. Bailey,
Cass Technical High School, Detroit, Mich.

The formation of an adequate conception of the work of the biology department practically demands the brief presentation of the organization of the science group since in all except the clinical technique curriculum biological courses may be regarded as related subjects.

The biology department forms one unit of what is known as the Science Group, headed by John C. Moore. This group sponsors the following six curricula which meet the requirements of the academic high school and in addition stress the sciences:

1. Science I which is intended for students who are planning to attend a college of engineering.
2. Science II for students wishing to prepare for college in medicine or dentistry or to become laboratory technicians or dietitians.
3. Pre-pharmacy.
4. Industrial chemistry.
5. Metallurgical.
6. Pre-nursing.

The science work is being extended to include one or two years of post graduate work for students in pharmacy, dietetics, clinical laboratory technique, industrial chemistry and metallurgy. This extension is in keeping with the growing tendency among cities to offer a year or more of college training in connection with high school courses.

Each curriculum provides for progressive development throughout the period of training in health, English, mathematics and the social sciences. These are regarded as the *core subjects*, essential to the development of personal and social efficiency. Elective subjects have been selected and the six curricula formulated so that the student may choose and prepare for a definite vocation. The term, vocation, is to be interpreted in the broad sense so that it may include college preparatory courses.

In the formulation of the various curricula and their revision, various industrial organizations and professional men have been consulted. Each line of work has developed in response to a direct need. For example, when the college of pharmacy was under consideration the curricula of seventy-five pharmacy schools were studied and from this assortment a curriculum worked out which it was thought would most adequately meet the students' needs. The curriculum was submitted to a committee of retail pharmacists representing the Detroit Retail Drug-

gist Association, the local branch of the American Pharmaceutical Association and the Michigan Pharmaceutical Association. As a result the pharmacy curriculum stresses the subjects especially suited to the needs of men entering the retail drug field and at the same time meets the requirements laid down by the American Conference of Pharmaceutical Faculties. Physiology and anatomy, botany, bacteriology, and microscopic analysis form the biological content of the College of Pharmacy Curriculum.

Likewise the clinical laboratory technique curriculum was submitted to a committee composed of members of the Wayne County Medical Society and Nurses' Committee.

The biological department of Cass Technical High has been attempting to solve the problem of enriched curricula during its three and a half years of existence. This has involved reconstruction of objectives, development of several courses of study to meet the requirements of the various curricula, formulation of the clinical laboratory technique curriculum, and the furnishing and equipping of the five recitation rooms and five laboratories which are assigned as follows:

1. Biology I and college botany.
2. Biology I and physiology and anatomy.
3. Biology II.
4. Bacteriology.
5. Clinical laboratory technique.

The equipment when completed will be modern and adequate for all necessary experimental purposes. Each of the five units according to needs are supplied with water, gas, electricity, compressed air, vacuum and equipment as follows:

a. General equipment, such as aquaria, demonstration microscopes, refrigerator, sterilizers, incubators, centrifuges, etc.

b. Twenty-four units of student's general equipment such as compound microscopes, dissecting microscopes, microscope lamps, double boilers, dissecting trays, ring stands, burette clamps, etc.

c. Individual student equipment sufficient for all experimental purposes which is assigned to student at beginning and checked in at close of semester.

In all the biological courses at least one-half of the students' time is spent in the laboratory solving practical problems and acquiring a technique helpful in later courses or in his chosen vocation. The class room work consists of lectures, reports on chosen or assigned readings, and class discussions. Frequent

use is made of charts, models, museum specimens, prepared microscopic mounts, lantern slides, films, and demonstration experiments. Visits to factories, health board laboratories, and industrial plants form an integral part of some of our courses.

The vocational subjects in the various curricula serve a diagnostic function. The work of the first and second years of the six curricula is very similar. During this period the students scientifically inclined have opportunity to visit laboratories, talk with older students and instructors and to determine in which of the related callings they may find the greatest opportunity for service. Their training is not intended to result in finished workers. The content of each curriculum results in the students becoming acquainted with materials and the technique of attacking problems when they enter into the pursuit of their chosen vocation and furnishes an excellent foundation for more rapid later progress in either industrial or collegiate work.

We consider the work of the science group of Cass Technical High as past the experimental stage. Of the 2,500 science students enrolled in the various curricula sponsored by the science group, five hundred fourteen at the present time are pursuing some biological course.

Our courses of study are the joint product of all the members of the department. The instructors have participated in their revision as well as formulation to such a degree that all feel the responsibility in carrying them out. We have adopted the policy of gradual rather than abrupt or wholesale revision. The use of mimeographed sheets for laboratory directions make it possible to readily modify any unit of the work to meet changing conditions or the needs of various groups.

In the development of our biology courses we have tried to veer from the formal logical organization of former years toward a more vital, but scientific, interpretation of daily life and at the same time to furnish the opportunity for the student to gain efficient detailed technical knowledge to aid him in the interpretation of later courses or experiences to be encountered. In other words, we feel that some progress has been made and that future revisions will make our courses contribute still more to the seven main objectives of education, since we realize that "Education is life itself—not a mere preparation for life."

As S. A. Courtis, director of instruction, Detroit public school says: "We live in a transition age, a time of storm and stress." His slogans, "Vitalization and socialization," are being gradually adopted. In many courses certain units of the work are being

carried on by groups and committees and much individual choice is exercised. It is interesting to observe the amount of self direction and self control which develops under student leadership when the teacher retires into the background and assists only in the forming and achieving of their purposes.

The time allotted to this paper limits the discussion of each biological course; however, I shall endeavor to give you some conception of each in that which remains:

(a) Biology is required in the first or second year of each of the seven curricula as an introduction to science and as a foundation for later biological and pharmaceutical courses. In each course the general fundamental biological principles are emphasized but the special needs of the various groups—science, pharmacy, nursing, dietetics, and industrial art, largely determine the choice of subject matter and laboratory materials.

(b) Physiology and anatomy is required in the third year of the pre-nursing curriculum. The course is designed to familiarize the student with the structure and function of the various systems of the normal human body and should form a background for interpretation of lectures connected with the nurses training after she affiliates with a hospital.

For the college students of pharmacy the lectures in physiology and anatomy deal primarily with the main organs and systems of special interest to the pharmacist. The general principles of physiology and hygiene are considered and structure is emphasized only as it relates to function. The laboratory work includes physiological experiments performed to demonstrate the activities of the various organs and to illustrate well recognized actions of drugs upon various tissues and organs.

A mammal is dissected and used in the interpretation of human anatomy. This course is also required during the first semester post-graduate work for students in occupational therapy and in clinical laboratory technique.

(c) In the college of pharmacy botany course attention is given mainly to the seed-bearing plants from which the official drugs are derived. In the three lowest groups of plant life emphasis is placed on the five or six species which furnish drugs official in most pharmacopaeias. Above are used so far as possible for laboratory and demonstration purposes. In case the usual type forms are used, special reference is made to roots, stems, seeds, etc., used in pharmacy and to the active principles upon which their medicinal value depends. The student ac-

quires technique in methods of killing, fixing, embedding, sectioning, staining, mounting, and observing, all of which are of considerable service in their later course in microscopic analysis.

(d) The course in bacteriology was introduced in consequence of the increasing importance of the lower organisms in the various industries, their effect upon the health, happiness, and prosperity of the people and the effectiveness of the present use of biological products as immunizing agents.

Four years ago its introduction into high school curricula was regarded as an innovation; however, it is past the experimental stage so far as we are concerned for at present 100 students are enrolled. This number includes the day, evening and continuation courses. General courses have been outlined for the Science I and Science II students and more specialized courses for the pre-pharmacy and pre-nursing groups. Next semester this subject will be offered sixteen clock hours a week to our second year college of pharmacy students and as soon as a sufficient number of fifth year industrial chemistry students demand our attention the general course will be modified to fit their special needs.

The general course is designed to make the student familiar with laboratory methods and technique and to enable him to gain a general knowledge of the relationship between micro and other organisms and the part they play in many important processes. Particular attention is given to the significance of micro-organisms in decomposition of organic materials resulting in harmless, desirable or injurious products; to the effect of bacterial deteriorated substances in the body; to their importance in agriculture and the industries, and to the methods of food preservation. The student learns the methods of handling, cultivating, isolating, identifying, staining and of studying non-pathogenic bacteria, yeasts and molds. Special attention is given to the principles involved and the effectiveness of various disinfectants and antiseptics. The physical means of sterilization are also used and emphasized. The course also involves the application of the bacteriological methods of milk, food, water, and sewage analysis with interpretation of results. Purification of water, methods of sewage disposal, production of immunizing agents and the control of the more prevalent pathogenic organisms are considered.

The course in pharmaceutical bacteriology is designed to give the student a general knowledge of laboratory methods and

technique, of the significance of micro-organisms in pharmaceutical practice, and of the cause of the more common bacterial and protozoan diseases and their control. Special attention is given to the significance of micro-organisms in the decomposition or organic materials resulting in harmless, desirable, or injurious products; to the effect of bacterial deteriorated substances in the body; to disinfectants, their preparation and use; to the source, production, preparation, and use of the various commercial immunizing agents; and to the storage and care of biologic products.

(e) Last September the clinical laboratory technique curriculum sponsored by the biological department was added to the college division. The newly equipped laboratory provides every facility for training in modern methods of making various clinical tests and examinations connected with blood analysis; urine analysis; gastric analysis; examination of sputum, pus, feces, spinal fluid; blood chemistry and serology.

ACTIVE PRINCIPLE OF PITUITARY GLAND FOUND.

The active principle of the pituitary gland has at last been isolated and purified. The announcement of this discovery, which adds one more to the list of glands the active agents of which have been separated in pure form, was made by the discoverer, Prof. John J. Abel of Johns Hopkins University, to the meeting at St. Louis of the Federation of American Societies for Experimental Biology. The only other pure glandular principles so far obtained by scientists are thyroxin from the thyroid gland, and adrenalin from the adrenal glands, both substances being of great use in medicine.

The impure extract of the pituitary gland is known in medicine as a powerful stimulant of the intestines and other structures containing involuntary muscles. It is a specific remedy for the disease known as *diabetes insipidus*, characterized by excessive activity of the kidneys but not to be confused with *diabetes mellitus* in which the sugar derived from food is excreted through the kidneys instead of being utilized in the system. Insulin, an extract of the pancreas discovered in 1922 by Drs. F. G. Banting and J. J. R. McLeod of Toronto, is a remedy for the latter disease.

Professor Abel has obtained pituitary extract as a highly purified salt of tartaric acid and believes it to be probably a single chemical compound which may be made synthetically in the laboratory. His preparation has already been used in several severe cases of *diabetes insipidus* with remarkable results and promises to be of use in hemorrhage, shock, and uterine inertia. It is 1,200 times as active as the powerful base, histamine, now used in medicine.

The substance isolated by Dr. Abel has been extracted from the posterior or nervous part of the pituitary body which lies at the base of the brain just above the roof of the mouth. The gland is in two parts. The front or anterior portion has an important influence on growth and cases of giantism or dwarfing are sometimes due to disturbances with its function. The posterior part of the gland possesses the powers exhibited by the principle which Dr. Abel has extracted from it and is also thought to have an important influence on sexual development.—[*Science Service.*

COMMON OBJECTIONS TO THE STUDY OF MATHEMATICS.

By A. J. Cave',
Houghton, Mich.

In order to be able to enjoy our task, it is of much importance that we be certain this task ought to be done because of its usefulness. The writer of this discussion has taught mathematics for a period of four years. It has become a common experience to him to be told that the study of mathematics is a stumbling block to a large number of high school students; that mathematics is being taught in a form too technical for the average high school student; that very many students do not enjoy the study of mathematics and are therefore unsuccessful in it; that students who are not mathematically inclined should not waste their time with the study of mathematics; that although it is considered the most difficult study in the curriculum, the study of mathematics is of least value if judged from a purely utility point of view. Does it surprise the reader that the writer is eager to weigh and sift these accusations in order that the truth may be given a high place in his own mind and a definite decision may be reached regarding the uselessness or usefulness of his daily task? The writer also is encouraged by a faint hope and wish that those who read this discussion may be less severe in their criticism of the study of mathematics if ever they have been severe.

The study of mathematics is a stumbling block to a large number of high school students. No one, I believe, is better qualified to understand the meaning of this statement than one whose task it is to instruct the youth in mathematics. The study of mathematics is a task in which proper sequence is of paramount importance. Its method may be compared with walking up a stairway or the construction of a building. In walking up a stairway, we must successfully take one step and then another. Some people skip a step, at times, but not very many. The foundation of a building and each succeeding part must have its proper proportion and strength in order that one may be steadfast upon the other. There is an unalterable rule in the study of mathematics which states that each part must be studied in proper logical sequence and with the highest degree of thoroughness. It is no doubt true that a student's success in the mathematical branches is directly proportional to the extent to which he has mastered all previous mathematical topics. It becomes quite evident, therefore, that any student

should stop as soon as his understanding of a particular branch of mathematics becomes vague. The only remedy lies in mastering the previous topic upon which the troublesome one is built. If such thoroughness is heeded by both the students and teachers, there will be a remarkable decrease in the number of pupils who find the required study of mathematics such an obstacle in their student life.

Mathematics is taught in high schools in a form which is too technical for students to comprehend. Theoretically, mathematics is not an exact science. Man is finite and cannot measure anything infinitely small. An attempt is made to make mathematics a science as exact as the finite mind of man can make it. The ideal of the entire science is exactness and certitude. It is because of this ideal that mathematics is a very technical subject. If we should endeavor to lessen its technical form, we should destroy much of its good, for its value for science and for the student's mind lies only in its precise method of reasoning. However, the intended value of the study of mathematics will be discussed later. I should like to suggest that the technical form of mathematics would become a very small obstacle to the average student if the study be pursued in its proper sequence, with proper intensity and application.

A large number of students do not like mathematics and are therefore unsuccessful in their attempt to master this subject. I can state with no small amount of certainty that the degree of interest we take in anything is directly dependent upon the quantity of information we have assimilated concerning that very thing. Is it not a common experience that an artist can more keenly appreciate a Rembrandt than one who is but poorly informed in the technique of picture-painting? Do you think a geologist with whom you look over a certain region can observe and enjoy a thousand things which your mind and eye can not? It seems quite inevitable that a proper amount of interest and enjoyment is safeguarded by a thorough mastery of the subject. The latter, however, is largely dependent upon the first point considered namely proper sequence with proper intensity and application from the very beginning.

Students who are not mathematically inclined should not waste their time with the study of mathematics. I am not able to say with any degree of certainty whether or not an inclination toward mathematics is inherited. Neither is it at all certain in my mind whether inability in mathematics is inherited. Stu-

dents have told me that their father or mother or both parents had always been poor in mathematics and that, as a result, they believed they were greatly handicapped. I certainly think that they were greatly handicapped but not in the same way as they do. They approached the subject with the consciousness of their supposed handicap. They were nearly defeated before they had really commenced. But if it were true that the inability to master mathematics is inherited, would it not be logical to emphasize the study of mathematics rather than discourage these individuals? The purpose of the study of any subject is to develop certain powers or qualities. If these qualities or latent powers are particularly undeveloped only a more intense training or a training extended over a longer period of time will remedy it. I am inclined to believe that a thorough mastery of the fundamentals by those who are troubled in this manner or who think themselves troubled in this manner would remedy a great deal. It is also plausible to suspect that a conscious knowledge of this handicap is as harmful as the handicap itself. In dealing with boys and girls, I have observed that there are some among them whose mind may be compared with a sponge. Just as a sponge can absorb a definite amount of liquid and no more, the mind of these boys and girls is capable of assimilating a certain amount of knowledge. Beyond that stage their mental growth is apparently very small, if any. The same has been noticed in individuals of certain races. These individuals, however, are not considered in this discussion and their problem is of a different kind.

Although mathematics is considered by many the most difficult subject in the curriculum, it is of least value when judged purely from a utility point of view. In other words, why should a student spend a large amount of time and effort in the attempt to master the Pythagorean theorem when, after he has left school, he shall never need it again? We have come to the most common objection to the study of a large part of mathematics. A truly inclusive and possibly conclusive presentation of this question would require a paper of many times this length. I shall humbly submit my views on this particular topic being aware of its difficulty of solution and my limited amount of information. Let us turn to an authority such as J. W. A. Young, Ph. D., associate professor of the Pedagogy of Mathematics in the University of Chicago. "Throughout all mathematics, from the first numbers lisped in the nursery to

the aged mathematician's last sigh, the chief end of mathematics is thought, not routine—natural thought, exercising the powers of the thinker in an unforced interested manner, not a forced and convulsive struggle for what is beyond grasp."

Before we could discuss logically the practical value of the study of mathematics it would first be advisable to define the meaning of practical value. This requirement is beyond my ability because people of various occupations have their own definitions of the meaning of practical value and differ greatly. The best attempt would be but a very general definition which would not be very serviceable to our purpose.

At times, those opposed to an extensive study of mathematics put questions which in themselves appear to ridicule an extensive study of the subject. For example, a man asked me once of what value an ability to solve a quadratic equation is to one who sells shirts, insurance or hats. If we should apply this same test to every subject taught in the high school, we should find that our whole educational system is sadly wrong. We should ask concerning the value of a knowledge of the Napoleonic period in selling shirts, insurance or hats. The same question may be put to a knowledge of Latin, French, physics, biology, physiology, botany, etc. We should find that the practical value of these subjects for study is surprisingly small if considered from such point of view.

This is an age of utility and we can not waste our time with anything which brings no useful returns. A large number of students who are successful in the study of mathematics continue their preparation and enter various fields of engineering. The practical value which they derive from their study of mathematics can not be disputed.

The writer knows a contractor who made a sad failure of his schoolwork while a boy. Teachers complained that he could and would do nothing but figure. At home, his parents tried to compel him to study the other branches as well. However, he liked to figure problems and was just stubborn enough to refuse to do anything else. I suppose he'll be figuring all his lifetime at building contracts and he promises to become a very successful man.

There are, however, a large number of students who do not enter engineering nor become contractors and we should deal with them as well. First of all, the high school is not primarily a vocational school. Boys and girls of high school age do not

know what lifework to choose. Numerous juniors and seniors in the high schools have never seriously thought about the problem of making a living for themselves and of being useful. They have been unable to discover the particular line of work in which they would fit in best. Due to different conditions for the youth in most European countries, we find but very few of high school age who have not a definite purpose in view. It is because of this condition that the American boy and girl should be subjected to a period of training in various branches. This experience will enable them to find that which they can do best and, generally, that is the very thing they like best.

We like to think that our mind or power of reason is employed in every transaction. We commonly consider it a praiseworthy quality to possess the ability to reason correctly. I dare say that we should like the world to think that the one thing we use most is our brain. Is it not axiomatic to say that the training of the mind is the foremost duty of educators? There is no subject in the curriculum which is better adapted for giving mental gymnastics than mathematics and any of the related sciences such as physics, astronomy, etc. We practice definite gymnastic exercises to harden our muscles. In the same way the student is asked to work through a large number of mathematical exercises to cultivate his power of reasoning.

You may ask in what special way the study of mathematics supplies this particular training in logical thinking. Let us turn to a particular branch of mathematics and the one which is least popular in the high schools. In the study of geometry, the student is asked to make a clear statement about the conditions of each problem including that which is to be proved or finally attained. Do we not attempt to state our serious problems in the same manner? Next the student is asked to break his previous statement into two parts. The first part, the hypothesis, states all the conditions of the problem or that which is given or granted. The second part, the conclusion, is a clear statement of what is to be attained or what the student should attempt to establish. We may as well call the first part "known conditions" and the second part the "aim." After that has been done, the student is required to reach the conclusion by working through a proof, step by step. In the argumentative statements of the proof each step is sustained by a reason which removes all doubt regarding the validity of each particular step. The aim is finally reached by the last step of the proof and the

problem is solved. The student who succeeds in the solution of the problem rejoices just as we who succeed in solving our problems of life are pleased with a feeling of satisfaction. The student who does not succeed in the solution of the problems, partly because of a poor foundation and largely because he lacks the will power to "stick to it," turns away with a feeling of dislike toward mathematics. Do we not find some of the latter type also in life outside the schoolroom?

It is because of the above stated opinions that I believe the teaching and study of mathematics a useful and important activity.

A SIMPLE AND EFFICIENT WIRELESS TELEPHONE RECEIVER.

By D. G. Veguist,
High School, St. Joseph, Mo.

One of the best receivers for high school students to make is the single circuit receiver. It is also suitable for the busy teacher who desires results at once. One can read these instructions, go to the dealer and buy the parts and listen to the broadcasting within twenty-four hours. With a set like this, KDKA at Pittsburgh, Pennsylvania, was heard clearly, as well as stations from all directions in the states including Georgia, Kentucky, Texas, Colorado, Michigan, Minnesota, Kansas, Nebraska, Iowa and Missouri. Only one tube was used. A two-stage set for loud speaking was made for the school. In this article necessary directions, diagrams, and lists of materials will be given so the author's set can be duplicated, and anyone who understands simple wiring can produce a most efficient receiver.

Procure the following materials:

1 43-plate variable condenser.
1 variocoupler (this can be made at large saving in cost).
1 00035 M. F. fixed condenser with 1-2 megohm leak.
1 0005 M. F. fixed condenser without leak.
1 6ohm rheostat.
1 pair 3,000 ohm phones.
1 Detector vacuum tube, 6 volt.
1 switch lever.
13 switch points.
2 switch stops.
1 22½ volt "B" battery (tapped battery preferred may be made up from flat flashlight batteries).
1 6 volt storage battery.
100 feet aerial wire.
Enough insulated No. 14 wire to reach from aerial to set.
1 piece of plateglass 7 1-2 by 12 inches about 5-16 inch thick.
1 telephone jack.
1 telephone plug.
3 binding posts.
Screws and wood for cabinet.

Dials for the condenser and variocoupler will be needed if they do not come with the instruments. Bar insulators and cotton clothesline will be needed to support the two ends of the aerial and insulators, where it enters the house. Also as one becomes skilled in operating the set, a 200 ohm potentiometer may be added.

If the variocoupler is to be made it is best to begin with it. Select a four-inch tube, seven inches long, of cardboard or other material. Beginning 5½ inches from the bottom secure the end of No. 20 double cotton-covered copper wire by means of holes in the tube so a loose end is left. Wind on *six* turns and then twist a loop in the wire without breaking it. Now wind on *four* turns and twist another loop like the first and underneath it and a little to one side wind on *eight* more series of four turns. The last series has eight turns, making fifty turns on the stator of the variocoupler. For some aerials more wire on the stator is desirable. This can be varied by making more turns in each series. Wind on sixty turns of No. 24 double cotton-covered copper wire on the rotor, which may be turned out of wood or, be a paper tube small enough to go inside the stator. *Thirty* turns are wound on each end so as to leave a space for the axle to go through. The outside ends go through the hollow axle for connections, a hole being made to let the wire through. After the windings are complete the rotor is fixed inside the stator by making holes through the stator tube with a cork-bore opposite the hole in the panel. This hole should be just above the windings on the stator. The rotor is fixed on the axle so turning the axle revolves the rotor. Fix the complete variocoupler in place after the panel is drilled and ready.

The Panel.

The panel can be of any material which is a good insulator. Plateglass is such a material and in addition it allows a view of the interior of the cabinet, which is valuable in instruction work. Glass is not difficult to work with. Take a three-cornered file of a size that will fit in the holes to be made and grind off the corrugations. With this a hole may be quickly drilled in glass if it be kept wet with turpentine. Care is necessary as the file goes through the underside of the glass. Mark all the holes over a piece of paper, which has the positions marked on it Use a large file for the large holes. Smooth the edges with an oil stone, wetting with water. In boring glass it should lay flat on a piece of soft wood. When the panel is ready make the

bottom and ends of the cabinet and fasten with screws. By putting washers on the screws, the glass panel is held in place. A narrow strip on top will hold the ends together, but do not enclose the back and top as this opening will be necessary in wiring the set.

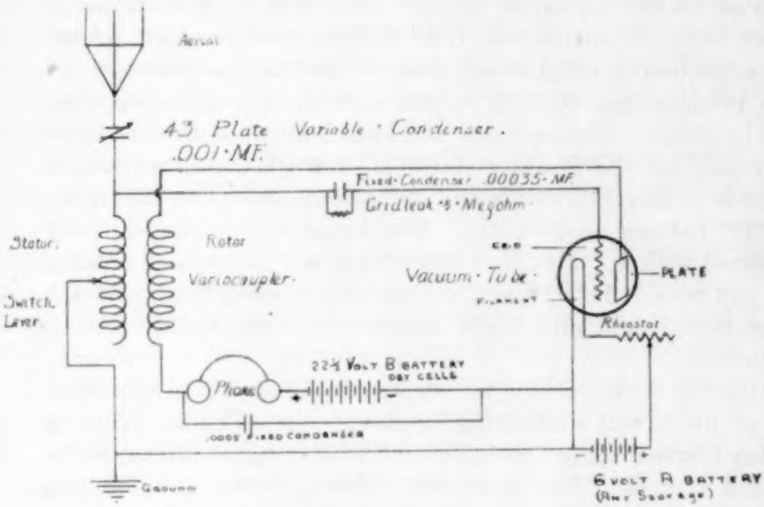

Diagram of the Hook up

Wiring the Set.

The diagram is to show how to wire the set, but should not be followed too closely as wires should not run parallel any more than necessary. Especially is this true of the grid lead. Fasten the variocoupler in place and as far from the condenser as possible. Scrape the taps bare and solder leads to them, connecting to the switch points in order so turning the switch lever to the right or clockwise increases the turns of wire. Connect the first tap to the condenser rotor. Connect the stationary plates of the condenser to the aerial. Using the diagram, connect up the set exactly as shown. Binding posts at the back properly labeled should be used to connect the batteries. Care is necessary here as the "B" battery connected across the filament would burn out the tube. The telephone jack is connected to the rotor lead and the plus "B" battery. The telephone plug is connected to the head set. If the head set is marked plus or minus, it should be connected to the "B" battery so the plus of the phone would be next to it. This is to preserve the phones' magnetism. Connect to a good ground such as a waterpipe, scraped clean or soldered. Connect to the aerial, which should be above sur-

rounding objects. When the batteries are connected the set is ready to operate.

Place the tube in the socket and turn on the rheostat until by turning the condenser a noise is heard in the receivers. Turning the rotor over may help as it may be opposed to the stator. Also adjust the voltage of the "B" battery if the potentiometer is not used. Turn the switch lever from point to point, adjust the condenser carefully each time as well as the rheostat. If any broadcasting stations in the vicinity are operating they will be heard. The operator will soon learn how to tune carefully and get the faraway stations. Burn the tube as low as possible to lengthen its life and do not put more than 22½ volts of "B" battery on its plate. Wonderful results can be easily obtained with it. This kind of a set will act like a weak sending set and so will help crystal sets in the neighborhood. At the same time it will give slight interference when the rheostat is disturbed.

After the set is working the wiring may be improved by soldering all joints and simplifying by shortening all leads. Number 16 hard drawn copper wire, covered with spagetti tubing, is the neatest and best. Use connectors on the ends that go to binding posts.

EXPERIMENTS FOR TESTING THE EINSTEIN RELATIVITY THEORY AT THE UNIVERSITY OF CHICAGO.

In referring to the experiments for testing the Einstein relativity theory at the University of Chicago, President Ernest DeWitt Burton at the recent Convocation quoted the following statement by Dean Henry G. Gale of the experiment which he and Professor Albert A. Michelson, Head of the Department of Physics, are now making:

"Messrs. Michelson and Gale have completed preliminary tests on their ether drift experiment which was designed to ascertain whether or not a beam of light traveling in a closed circuit on the earth's surface experiences a drag as a result of the earth's rotation. The preliminary experiments have shown that the difficulties of the measurement can be surmounted, and work is under way in preparation for the final experiment which will be carried out in the spring."

President Burton added that the other men whose researches Dean Gale reported are over thirty in number.

Believing that a curb should be put upon the establishment of small high schools in communities too small to maintain them properly, Virginia's State Department of Education, with the co-operation of the United States Bureau of Education, is making a study of high schools in two counties. From the result of this study it is expected to develop a policy favoring the establishment of schools maintained by counties rather than by districts. This should bring about larger and better schools in the opinion of the Virginia authorities.

THE PROBLEM METHOD OF TEACHING AND STUDENT DISHONESTY

By Elmer Campbell,
Purdue University, LaFayette, Ind.

Student dishonesty is doubtless perennial in most institutions of learning. The preventive measures offered in this short paper are based upon an actual experience of three years in what may be loosely called the problem method of teaching botany. Even the expressions that seem to be purely theory have had their promptings and sanctions in real practice.

The suggestions are offered entirely from the teacher's viewpoint. Student testimonials are reserved for a later presentation.

Only three points of control are herein mentioned, namely:

1. Close personal contact between student and teacher in the laboratory, where problems, for which a foundation has been laid in the class room, are personally and directly demonstrated by the student to the teacher. By such repeated contact the instructor *develops a true and inviolable* estimation of his student.

2. Written reports and probationary examination papers are not graded but are red-penciled and returned to the student for class room discussion and clarification. Here it is known that the test is an *instrument* in a *continuous* process, not a *marker* of an *end-point.*

3. A final examination is given, upon which grades are issued, each question of which as far as possible, is made to involve three distinct values:

(a) A legitimate and reasonable use of facts.
(b) A transformation of definitions to ideas.
(c) An application requiring thought.

Student cheating in any classroom is only a *dishonorable* effort to appear *honorable*, the honor sought being a passing grade, a high mark, a degree, etc. But it seems possible for the teacher to seal a mutual fellowship between himself and his students with the spirit of one eternal law, an *extorted learning* is as impossible and unthinkable as is a *dishonorable honor.*

The potential crook instinctively knows that he can not thieve the *properties of knowledge.* But in most systems of education there are certain *inferior, over-guarded and easily obtainable articles* upon which he may lay his sneaking hands.

Test papers and written reports should never be required as so much currency in exchange for the passage of a course, as such they are of questionable value and suggestive of crookedness.

When a student has brought himself into a commendable attitude of mind and has satisfactorily demonstrated his ability to operate prescribed processes involving, for him, the creation of *new ideas*, and the mastery of certain *fundmentals*, he should be rated directly and entirely upon these high values and nothing less.

If when a group of questions are set before a student, in monthly tests, he is made to feel that upon his answers he stands or falls, *knowing* and *not knowing* thus become equally final, and if under these conditions he abhors the dishonor of "flunking" above all others, the inevitable may happen.

It requires continuous and progressive training in the fine arts of *pedagogical culture* for a teacher to keep himself free from certain *fallacies* and *absurdities* of the pseudopedagog.

The true teacher is not a *guardian dispenser* of a selected group of facts, he is a lifter and *leader* of human souls, the promised land of which is not for him even to see. As such he can never set before his students, problems whose solutions are illegally obtainable.

Too often full and permanent stops are made a long way off from the true value of education. As a possible illustration of this fact the following list of questions recently given on a certain written test in systematic botany may be here discussed.

1. Name and describe three kinds of plants as to duration.

Much can be honorably said in answer to this question all of which may be *meaningful* to the examiner and *meaningless* to the examinee. A perfect answer is also easily sneakable.

In the problem method, the student takes a spade and goes with his instructor into the field, digs up a plant and demonstrates how he knows it to be an annual, biennial or perennial, touching with his *own forefinger* the visible marks of proof. Thus he performs an operation that is likely to quicken his mental honor and discernment and generate a desire for larger things, if not, at least, he finds nothing to steal.

2. Define hypogyny and epigyny.

These words may be perfectly and squarely defined by a student who has not the slightest idea of their meaning. When thus handled by him he is legitimately given a *high grade*, and yet the thing he has done is *absurdly small* as an educational value. This question also is an easy mark for the crook.

In the problem method of teaching, flowers of various types are given to the student and he points out to the instructor, hypo-

gyny, and epigyny, demonstrating that he knows when the other floral parts are attached below the pistil that condition is designated as hypogyny, and that in epigyny the other floral parts are attached upon the pistil. Thus he not only proves his mastery of abstract definitions, but that he has much finer attainments of knowing the concrete when he meets it, and of transforming dead *definitions* into living *ideas*.

The student that cannot thus *perform in the laboratory*, should certainly not be asked to give an *elocutionary performance*, or to *write an editorial* on the subject, elsewhere.

3. Sketch a perfect incomplete flower, labeling all the parts.

This is an excellent question to ask a student in private conference, but for obvious reasons should not be used in a written test.

In the problem method the student is given a typically complete flower with the request to operate upon it in such a way as to make it perfect and incomplete. If the instructor sees him at close personal range do this thing in the laboratory, why postpone the grading and why shift its bases to notebooks,, reports and test papers?

In the laboratory a student can be led to seek the real purposes of facts and to make immediate application of them, whereas in the test room the *purpose* of all knowledge is reducible to the level of *passing a quiz*, when thus brought down the seeker thereof is not honor bound.

4. Name and describe three kinds of floral incompleteness, using technical terms.

The purpose of such knowledge as this question demands is taxonomic, but mere *facts* can not serve the purpose. A student may answer this and a dozen other questions of like purpose and yet be pitifully powerless in the science of plant tracing. In systematic botany the *facts* of apetaly, staminateness and pistillateness are not *needful*, but a *ready and clear recognition* of such *conditions* in a flower is *indispensable*. So in the problem method of teaching the student is provided with material from which he gains knowledge by observing natural conditions, the purposes of such knowledge are sought, applications are made and each conclusion reached is immediately applied toward the ascertainment of new and bigger conclusions.

That a flower is pistillate means nothing as a fact, the information is useful only as a mental lead toward a semifinal thing, the *name of a plant*. When this point is reached the student

may pause a while, but who can say what the end of such a mental process shall be? If the four above questions are asked in written tests, it should be only following their complete involvement in the laboratory, and they should appear in a form, fraught with big possibilities of asperation and inspiration. A suggested new form is as follows:

1. What apparent advantages are gained in nature and for man by the various duration habits of plants? Describe your method of determining these habits.

2. As to the placement of the other floral parts relative to the pistil, what can you say? What is the application of such knowledge?

3. Discuss briefly how a flower can be incomplete and perfect at the same time. Make a sketch to demonstrate your discussion.

4. Technically name the possible points of incompleteness in a flower and state the biological significance of each.

The problem method thus seeks the *minimization* of the *trivial* and *thievable* things of life, and the *maximization* of those *vital values* that thieves can not approach to steal.

PROJECT TO HARNESS BAY OF FUNDY TIDES.

Application for permission to harness a small part of the mighty tides of the Bay of Fundy, between Nova Scotia and the mainland, has been made to the Federal Power Commission, disclosing one of the most ambitious water power projects ever conceived. The scheme involves the damming of Passamaquoddy Bay between Maine and New Brunswick by five miles of dams between the mainland and intervening islands.

Passamaquoddy Bay opens into the Bay of Fundy where the tidal range averages 35 feet. It is proposed to install a system of gates that will maintain an operating head of from 27 to 16 feet at all times, developing from 400,000 to 500,000 horsepower.

The great difficulties to the project are engineering and those due to the interruption of navigation. A maximum depth of 200 feet of water will be encountered on the dam site. Vessels bound to or from Eastport, Lubec, or Calais, Me., or St. Andrews, N. B., would have to be locked through the dam, and it would be difficult to construct locks which might be used in rough weather, thus greatly impairing the value of these ports as harbors of refuge in storms.

The applicant for permit is Dexter P. Cooper of New York, who asks for three years in which to make preliminary surveys.—[*Science Service.*

At the recent Country Life Conference held in St. Louis a moving-picture film was shown of a farm boy and his prize flock of chickens. The birds were fine because the boy had a scientific knowledge of chicken culture and had applied his knowledge to the care of his flock. But the boy was a mouth breather and showed further effects of malnutrition. The chickens were better cared for than the boy.

GENERAL SCIENCE A FOUNDATION STONE.

BY HENRY P. HARLEY,

Fairmount Junior High School, Cleveland, Ohio.

"Laying foundations for vocations," the slogan for our convention, perhaps is a new objective to many of our general science teachers. We have been keeping before us such aims that seek to develop within the pupil certain habits resulting in clear thinking. In view of this the pupil is trained to weigh all evidence, to persevere in securing facts, to record results with accuracy, and to suspend judgment until sufficient evidence is present to warrant a conclusion. Further we are presenting to our classes such opportunities that open the great fields of science touching his everyday life; material that appeals to his needs and interests; material that opens to him the beauties of nature's laws; material that shall stimulate him to persevere in adjusting himself to our ever increasing scientific age.

The general science teacher, or better, the instructor of everyday science should be inspired with the importance of his opportunities. Too often do we hear from him remarks of uncertainty as to enthusiasm and procedure. There is no subject in the curriculum fraught with a wider range of material, more contacts of interest or greater possibilities for application. The range of material and interest need not worry the careful teacher for his subject affords the only real unity, the unity of life.

The findings of natural science are of almost universal interest today. Active minds everywhere are seeking new fields for research. No subject or study can be rightfully pursued without the methods of observation and experiment. Moreover, present day thought on political, social and religious topics is more and more using scientific data as their fundamental premises. Therefore in the words of Professor DeGarmo, "Wherever men work, in trade, in production, in government or courts, in charity or social reform, in education, in the home or the church, they need the methods of science in applying effectively the truths that science has revealed."

The general science teacher even though possessed with all these aims, methods, materials and enthusiasm works with a disadvantage if he does not project into the after life of his pupils a vision of requirements, opportunities and interests connected with their daily work of the future. As he faces boys and girls of twelve and fourteen years he should realize he is laying the foundation for future citizens to understand their

world at the ages of thirty and forty. A great factor in their future lives for happiness and richness of experience will be their vocation. While the general science teacher is too busy to teach vocations as such he cannot afford to miss the chance of laying foundation stones in the characters of potential citizens that will assist in making of their future work not a task of drudgery or necessity, but a trade or profession that will be a pleasure because they understand the interesting phenomena surrounding their everyday lives.

Accordingly the elementary science teacher being fully aware of the fact that for many of his pupils his course constitutes the greater part of their science instruction, should keep in mind the field of vocations where his pupils will work in after years. It is scarcely necessary to recall the impossibility of foretelling in all cases the future vocation of the adolescent pupil. But we know he will likely be found somewhere in agriculture, in business, a trade or profession.

We may for our own purposes classify the vocations of the world somewhat as follows:

I. Professions.
- Ministry.
- Teaching and School Administration.
- Journalism.
- Law.
- Statesmanship.
- Medicine.
- Dentistry.
- Nursing.

II. Fine Arts.
- Painting.
- Sculpture.
- Music.
- Poetry.

III. Applied Art.
- Domestic Economy.
- Bookbinding.
- Printing.

IV. Engineering.
- Civil.
- Municipal and Sanitary.
- Mechanical.
- Electrical.
- Mining.
- Metallurgical.
- Chemical.
- Architectural.

V. Commerce.
- Business Administration.
- Accounting.
- Secretaryship.
- Salesmanship.
- Advertising.

VI. Agriculture.
- General Agriculture.
- Horticulture.
- Landscape Gardening.

VII. Building Trades.
- Carpentry.
- Bricklaying.
- Plastering.
- Plumbing.
- Cabinet-Making.
- Painting and Decorating.

VIII. Machine Trades.
- Machinist.
- Experimental Worker.
- Pattern Maker.
- Blacksmith.

IX. Transportation.
- Operating Signal Devices.
- Traffic Administration.

As the teacher faces his class he knows that each pupil before him will some day be working in connection with one of the vocations listed above. Let us see how their training in the

general science course may have a bearing on the success of our future citizens in regard to their daily work.

The direct bearing of science instruction to medicine, engineering, domestic economy and agriculture is selfevident. However, while science instruction should not become "an austere and solemn business," the introductory class is not too early to train for caution and rigor in testing generalizations essential in these great applied sciences of today. Moreover I would like to emphasize the importance of science instruction in rural districts. The farm and its equipment furnishes a great laboratory for study and research. It is a most fascinating place for a scientific student. The principles underlying the common phenomena such as the difference between dead grass and real hay have real interest. Instilling a love for scientific study ought to keep more of our young people on the farms with a desire to possess their own property.

Many of the academic pupils will go out into such learned professions as the ministry, teaching, law, statesmanship, etc. Instead of there being antagonism between science and religion, there should be hearty accord. What more inspirational and reverential study can there be made anywhere, except in the Bible itself, than the infinite forces of nature or the marvelous harmony of the spheres. Every lesson should make a lasting impression as to the wonders and beauty surrounding the adolescent pupil. So instead of hearing from the pulpit such information as "A comet is a ball of fire flung from the hand of an angry God to warn the grovelling dwellers of earth," we shall hear emphasized rather from the scientifically trained minister: "The heavens declare the glory of God and the firmament showeth His handywork."

Teachers of all grades and subjects are in many places being called upon to pursue their work in a scientific way. Recently there came from headquarters of the Cleveland Board of Education this request to the teaching staff: "What new things did you try to do this year?" This request was not made for the purpose of discovering what new things we read about, but what we as teachers discovered in a scientific way by experimentation. Educational research and methods of teaching will be done increasingly according to the methods of science and will be based on the data of science.

What lawyer representing criminal or civil cases would hope

to succeed in the affairs of our daily life without early acquiring the habits of scientific procedure, or early beginning that acquisition of information that he may wish to call upon with scarcely a moment's warning. A court trial may at very short notice develop into a contest of scientific discussion.

The teacher with a vision sees a number of his pupils following these responsible positions with an early training in the general science class, laying the foundation for broadening their view of life, bringing into contact with real materials those who will rather largely deal with abstract ideas. Quoting the F. W. Parker *School Year Book of 1915*, "Their concrete experience must be rich and varied if their mental advancement is to be full and free."

A great many children of our public schools will go out into commercial life, into the subordinate positions of accounting, secretaryship, salesmanship, and advertising. Knowing that modern commercial enterprises, especially manufacturing, with well equipped laboratories, have scientific data as the foundation of their very existence, the general science teacher will see these pupils greatly handicapped unless they have developed within themselves the appreciation of, and ability to do, reading and research work in the sciences underlying the particular business of the firm for which he is working. Moreover, the teacher in correcting experiments recorded in note books reminds himself continually that these future bookkeepers, stenographers and salesmen will be face to face with the proposition that errors represent money in the business office, untidiness and poor form will mean demotion or discharge; while on the other hand, accuracy, initiative, the artistic touch, and neatness result in promotion and further opportunity.

The building and machine trades afford a vast field for scientific study and application. Composition, formation or growth of raw materials, tools and tool steel, machinery, care of machines, transmission of power, veneering, soldering, effects of heat on materials, stress and strain on materials, electricity and care of the finished product, all have for their foundation scientific principles which the tradesman should be able to appreciate. The thoughtful general science teacher will remember the great many boys and girls who go out into industry. If he succeeds in stimulating their interest in science sufficiently, creating a desire to study the science of their own trade in after life, his efforts are most valuable.

But let us be real scientists and not go to extremes. Let us not presume to outline definitely the future course of the pupil. True it is elementary science will pave the way for future special sciences, and the teacher can accomplish much in the way of guidance in the activities of the future citizen, but may we never forget to provide a field for the growth and cultivation in the pupil of that initiative which will explore many interests and find those contacts appealing to him most strongly, and for which he is best adapted. In the words of Mr. Robert M. Gay: "Let us have at least one part of our brains from which the pedagogue shall be excluded; let us reserve at least one large section free from scientific farming, one tract of wild woodland with plenty of underbrush, where commercial fertilizer shall be unknown, and humus, or leaf mould, blown in from the four corners of the earth and the instellar spaces, shall form a rich deposit in which the native sprouts can germinate, take root, and flourish."

Let us therefore as teachers of general science have a vision of the great world of vocations into which our pupils will sooner or later go. We should not seek to determine their destiny, but guard against habits that will militate against efforts toward success and good citizenship. For the future vocation of the pupil, general science, with its wealth of material, its many-sided interests, with life as its unity, and clear thinking as its goal, is a foundation stone.

CANAL TRAFFIC LIMITS SET BY WATER SUPPLY.

One quarter of the water of Gatun Lake which supplies the Panama Canal is used up during the dry season, in the operation of the great locks or lost through evaporation, Secretary Weeks of the War Department said in a radio talk recently. Traffic during the dry season would be limited under present conditions to about fifty vessels a day because there would not be enough water in the lake to lock any more vessels through, he declared.

Approximately eleven vessels pass through the canal daily, the greatest number in any one day having been thirty-eight. Fifty vessels can be accommodated in one day but it is considered improbable that this number could be handled every day for all days in the year, since further utilization of the water of the lake would decrease the depth of water in the channel.

Secretary Weeks said that when the time came to increase the capacity of the canal the additional supply could be financed from the increased tolls from the increased traffic.—[*Science Service.*

Hexamethylenetriperoxidiamine has been tested by the Bureau of Mines to determine its detonating value. It is an explosive that may be useful in armor-piercing shells.

VITALIZING THE PROBLEMS OF GOOD CITIZENSHIP BY MEANS OF THE GENERAL SCIENCE COURSE.

By G. A. Bowden,

University School, Cincinnati, Ohio.

A century ago the bulk of the people of the United States were farmers. The family group was quite independent and carried on a comparatively isolated existence. The labors within the family group or organized household were sufficient to meet the needs and wants which were concerned with food and clothing. The farmers raised sheep and sheared them, carded and spun and wove their own woolens. They raised flax, and from it made linens. Beef and pork, poultry and dairy products, and vegetables and fruits sprung directly from the united labors of the family unit. Firewood and building materials were in abundance and near at hand. The homemade candle provided sufficient artificial light for these people, among whom it was the rule of life to rise with the daylight and to go to bed when it was dark. For a share of the grain, the neighboring miller ground the wheat and corn to flour and meal. Teas and silks and similar luxuries were obtained by direct exchange for whatever products the farmer had in excess of his family needs. The village blacksmith, the doctor, the pastor, and the schoolmaster were paid in part with products that resulted from the handiwork of the several families among whom they labored. In short, those early families had everything that they needed except money, and they had little need for that. What money there was, was hard to get, and it was always reserved for the payment of taxes. Consequently, the government and its few and limited agencies were at this time regarded as outside affairs, of which the less the people heard the better. While the government was popular in form, it was wholly apart from the immediate needs and interests of the family.

The children of this early period found themselves in a social situation that was easily comprehensible. Indeed, the greater portion of the children were not mere observers in the affairs of life, but were active participants in the many pursuits that related to their and their families' welfare. They aided in caring for the herds, turning the soil, planting the grains, gathering the harvests, and preparing the raw materials for food and shelter. The problems of the family and each of its members were the concern of all—young and old. Heavy toil rested on human hands, and human life was of necessity simple. To live amid

such conditions was to practice self denial and strict economy, which developed the power of self-restraint and the habit of thrift—the remarkable traits of our immediate forefathers.

When invention harnessed steam with steel and brought into existence the many labor-saving devices, humanity stood on a new threshold. Man's wants increased, and the primitive methods of farming gave way to new methods in which labor-saving machines made it possible to bring into existence greater supplies of raw materials for food and clothing. Today the improvement is such as to allow five men with modern farm machinery to do the labor of one hundred European peasants without machinery. Consequently, those who are not needed on the farm find their way to the cities and are employed in the manufacture of finished products from the raw materials of the farm and mine.

Moreover, the American agricultural colleges have taken up the question of crop improvement and soil conservation to the end that farm yields are ever on the increase for the amount of labor so employed. Added to this has been the constant opening up of new and fertile regions, which have more than made good the losses of the old and exhausted soils of older regions.

Furthermore, the building of railroads and telegraph lines made possible the sale of foods and their transportation from distant farms to the markets of the ever-growing city. The advantages of rapid transportation, with its huge capacity for carrying raw materials from distant points, grouped vast manufacturing industries in and about cities. As such enterprises grew, greater numbers of working men from farms and foreign countries took up their residence about the industrial center. While these causes and conditions are the main factors that contributed to the great growth of our densely populated centers, many others were in operation and served to guide the human stream in one direction—toward the American city.

The facts point out that the nineteenth century gave us the conditions that brought our present-day city into existence. While those living in the nineteenth century gave us the large city, they were quite unable to give it to us with its many problems solved and in good working order. The problems of the great city are for us of the twentieth century. We must become fitted and trained in the art of city building and city improvement, if we wish to succeed as a people—as a nation. The large city and its continuous growth constitutes the greatest of all problems of modern civilization.

From colonial time to the present there has always been a strong tendency in America for cities, towns, and countries to govern themselves. Consequently, when we read the ordinances put into effect by the Select Councils of our early American villages, we are able to get a clear picture of their attempts toward the supervision and the control of those things used in common and toward the maintenance of public health and safety. Indeed, these efforts on the part of our forefathers in behalf of a more wholesome village household furnish us with striking examples for the teaching of lessons in modern municipal housekeeping. For example, during the years 1802-1814 the Select Council for the Village of Cincinnati adopted the following ordinances:

1. To organize a night watch of all male citizens over twenty-one years to be divided into twenty classes who shall patrol the city at night.
2. To compel citizens to remove logs and other debris from the roads.
3. To establish a market and to see that goods are sold at full weight.
4. To provide that chimneys shall be built of stone or brick.
5. To elevate, grade, and pave from sidewalks.
6. To tax all theatrical and puppet shows.
7. To prevent chickens from trespassing, and pigs from running at large.
8. To prevent the spread of smallpox through segregation and vaccination.
9. To compel property owners to fill up places where stagnant water stands in pools.
10. To secure a quiet Sabbath.

Each of these ordinances presents subject-matter of the richest sort and worthy of the most serious study on the part of classes in history, civics, biology, and general science. For an examination of the ordinances shows that the greater number of them are concerned with problems dealing with the security and the safety of life and property and with questions of community health. The Select Councils of these early villages were forced to make rules and regulations because some of their inhabitants endangered the welfare of the community. Some dealt in short weights and practiced dishonesty. Some trespassed or, worse, allowed their animals to trespass. Some had pools of stagnant water which were objectionable for many reasons. Some allowed filth to accumulate in roads over which they and others had to travel. Others broadcast the germs of disease and thus endangered the health of all. Some of these offenders were ignorant and knew no better. Others were willful and selfish and had no thought of community welfare. Still others were deliberately opposed to a community organization of any kind and were unwilling to co-operate in the safeguarding and up-

building of the community interests. The picture of the community life in the early village displays to us in a forcible way the two kinds of citizens that composed its populace—the destructive and the constructive. The picture is, indeed, simple; its portrayal of the opposing forces is clear; we understand the situation, and we regret the presence of a destructive opposition of ignorance, willfulness, selfishness, and deliberate unwillingness to co-operate in securing that which is right and well.

It is much the same in our great and overgrown cities of today. There are still great groups of people who are ignorant of the real purpose of the community in which they live; they have no community ideals, and having no ideals, they have no community interests. They lie, cheat, steal, burn, kill, destroy, intrigue, corrupt, pollute, waste and broadcast disease. They are destructively employed. They contribute nothing to the co-operative efforts that strive for improvement. Nor is that all. The necessity for dealing with such people withdraws a considerable portion of the best laboring forces of the community into protective agencies of various sorts. We have policemen, constables, magistrates, jail keepers, food inspectors, censors and detectives—public and private. These protectors are just as necessary today as they were in the pioneer village of earlier days. It seems unfortunate that so much protection and detection of every sort is essential for the maintenance of social order in our great community households.

The troubles of the modern American city, and of the state and nation as well, rise from one particular source; the idea that we can legislate our evils out of existence rather than dissolve these evils through training and education. So long as we continue to stem selfish impulses of humanity through the channels of legislation and the enforcement of legislation, just so long will these same impulses continue their evil opposition to that which is right and best for social existence. For the legislation of laws and the enforcement of laws can never give to the ignorant the fruits of learning, nor to the indolent the compensations of industry, nor to the indifferent the rewards of ambition, nor to the depraved the merits of virtue. The utmost that any government can do is to protect men, not against the wrong that they do unto themselves, but—and only in small measure—against the wrong that is done unto them by others.

For a century and a half our nation has existed under a form of popular self-government. At first its functions were necessar-

ily few and simple. Today its offices are many and varied. Throughout this period of development and transition, our press, our public orators, and our schoolmasters have defined *popular self-government as organized self-control—the organized capacity of all for the development of all.* While this definition of popular government seems ideal, we must not delude ourselves with the notion that such an ideal of human existence and interrelationship has yet been accomplished. For it is under a popular form of government that we find the selfish and the cruel passions in serious conflict with the good and the noble impulses that seek to establish honesty and virtue—public purity—in social order. It is these tremendous forces for good or evil that express themselves in laws, in the enforcement of laws, in contempt for laws, in good administration and in bad administration. When popular self-government is good, security, success, contentment, and development come according to the capacity and the courage of those who respect the government which they themselves have created; when this respect is wanting, government is bad and disaster comes to all. Under good government, industry and comfort flourish even though the soil be quite sterile and the climate rigorous. On account of bad government some of the fairest and most fertile spots of the earth have become wildernesses, or habitations of squalor and wretchedness.

The fulfillment of the purposes of a popular government—the permanence of modern civilization—can never be accomplished except by a process of evolution through education and practice in which the great masses of humanity acquire self-restraint, soberness of judgment, and loyalty to the fundamental principles that are so essential to stable and effective government. The philosophy of morals, the teachings of history, in short, the whole experience of the human family points to but one conclusion—that in the conduct of life the most difficult and the most essential virtue is that of self-restraint. It is the first lesson of infancy; it is the characteristic for which kings and captains are most highly lauded; those who have it not are shunned and feared; it is needed most where power is greatest; and it is needed more by men acting in masses than by individuals, because men in masses are more irresponsible and difficult of control than individuals. Consequently, the success of our present-day democracy is dependent upon the degree of advancement that is made in social education—a type of education that has to do with the responsibility of associated living.

The question of the hour is how we shall educate for intelligent participation in a social democracy. The principles of modern psychology point the way. If we are to prepare the child of today for serviceability on the morrow, we must make use of those experiences of the child that bear on the characteristics which we wish to develop. The social experiences of the child of the past century were on the whole simple and easily comprehensible. The social experiences of the child of today are greatly complicated and difficult of comprehension. A century ago the arts of life lay fully revealed; there was no mystery in the relationship of wheat fields to the loaves of bread or that of the black sheep to the little boy up in the lane. The entire industrial process stood disclosed and the whole of the social situation was meaningful. The home of today provides no such opportunity for experiencing a round of activities that have to do with the arts of life. The immediate community in which the child is born and reared provides a social existence that is essentially meaningless. So much a matter of routine is every movement, so timed is every act of life, so intricately interrelated are the arts of life in the organized whole of life—the community—which the child finds about himself, that he accepts as natural that which is wholly artificial. So real is the seeming naturalness of it all that he conceives life to be one of individual independence rather than one of social interdependence. These misconceptions are carried, not only throughout childhood and youth, but often throughout life. Such misconceptions handicap not merely the individual who believes and practices them, but the great social unit in which he takes his place. The misconceptions acquired in youth are the source of much of our present day spirit of selfish intolerance, which makes impossible the perfection of associated living. The acquirement of false conceptions of community life on the part of the youth is directly chargeable to society itself, for the reason that it fails to provide and to equip its growing youth with such experience as will give a clear vision of worthy ideals in social living and social improvement.

It is essential, then, that the many institutional groups that make up society busy themselves and reveal to its youth the relationship of things as they are. The fundamental institutional groups of the community are the family, the school, and the church. While each of these labors permanently for some

common purpose peculiar to itself, it is from these that come the great moral forces that run through the community organization and weld it into a common whole. Much could be said about the importance of each of these great institutions and the dependence of the community upon the success of each. Of these institutions the family is the essential one, and since its communal existence demands that it live in combination and organization with other families that are equally dependent, it is essential to set up community standards of conduct regarding domestic relationship. Such a domestic relationship gathers the whole of the community into one big household in which it is necessary to do collective housekeeping in order to preserve in good order those things which the people use in common. That is, the community household is concerned with problems that have to do with supplies of wholesome water, sanitation, food inspection, clean air, protection against infectious diseases, and with many others relating to community welfare. The solution of community problems depends directly upon the interest of the many individuals of the community. If individual citizens are not interested in wholesome drinking water, it is not likely that the community will be provided with good water. A clean city is very likely to be a relatively healthful community. But city cleanliness consists of cleanliness of shop and factory, and cleanliness of alleys and streets in the neighborhood of the home, shop, and factory. But individuals who are not acquainted with the importance of wholesome water, pure air, and sanitation are apt to hinder and oppose these undertakings so essential to the welfare and happiness of the community. In order, then, to quicken the public spirit, to stimulate a stronger desire for co-operation, and to bring about a feeling of greater responsibility on the part of the developing youth, it is fundamental that our educational systems take a more active part and portion in preparing the youth of the present for a greater and truer citizenship in the future. For it is only as new life comes into society that opportunity arises to improve the character of life.

When we examine the curricula of our elementary and secondary systems of education, we find that the old dualism which would classify subjects as cultural or noncultural, as humanistic or scientific, as esthetic or materialistic, is rapidly dying out. All subjects are cultural in the degree to which they develop wider appreciations of that which is worthy in life. When properly conducted and interpreted, study in any of the courses in science

develops an appreciation of the inner meanings and connections of things, an appreciation of the service of science to the life and civilization of our time, an appreciation of the slow, painstaking efforts and tremendous toil with which scientific progress has been accomplished, and an appreciation of the privileges, duties and responsibilities that living in this age of science involves. It is a serious indictment of science-teaching to charge that it overlooks any of these fundamental relationships. Furthermore, the sciences touch upon the efficiency of life in the home and the community at every angle. General science, biology, physiology, physics, chemistry, all have definite services to render toward the proper organization, use and support of life in associated living. The sum total of all instruction in general science should aim at the realization of the six objectives of right living—health, worthy home membership, vocation, citizenship, the worthy use of leisure and an ethical character. In order to secure the accomplishment of these aims and ends, courses in general science find their place in the curricula of our schools, not as substitutes for any one or more of the special sciences but as a basis for the discovery of interest in the science of right living. They enlarge vocational opportunity and prove to be the best training for those pupils who can take only one science course. To accomplish their purpose, they find their subject matter in the environment of the home and the community; they deal with the forces and materials in nature and their adjustment to the comforts of man, with the conditions of life and growth, and with means for their improvement.

Children of northern Newfoundland and Labrador are growing up in unwholesome surroundings, with deficient diet, little fresh air, few educational advantages, and much hard work, says Evelyn C. Schmidt in the January number of "School Life," published by the United States Bureau of Education. The water supply is poor and the houses have no drainage. Without milk, vegetables, fruit, or cereals, many of the children suffer from diseases caused by deficiency of diet, such as scurvy, beri-beri, and rickets; many have tuberculosis.

Education is a serious problem because of the denominational system of schools. In a small settlement there may be families with children of school age belonging to two or three different churches—Methodist, Anglican, Roman Catholic—or to the Salvation Army, each faction trying to maintain a school of its own. If that is financially impossible, and it usually is, the community has no school at all. The inevitable result is that the white population of the coast is largely illiterate. Missionaries have done good work in teaching the Eskimos, and Doctor Grenfell has added to his medical staff summer workers who teach children a little school work and some simple rules of health.

INTERESTING PUPILS IN PLANTS AND ANIMALS.

By W. C. Croxton,

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It is in no sense my purpose to argue for any particular organization or method of teaching biology. I hope to present some workable suggestions for enlisting interest in certain phases of the subject. I have tried to keep in mind the directions received from our chairman and two members of the program committee to the effect that I present some classroom helps. The suggestions I offer doubtless will not be new to all of you. However, I hope there will be something of use to teachers of unified biology, botany and zoology. I trust you will feel free to interrupt me to ask questions or references at any time. I shall especially appreciate it if you will, in return, give me the benefit of your experience.

Inasmuch as I am limited to twenty minutes, it seemed best to confine my suggestions to one or two phases of biology. I have chosen an animal and a plant type. Insects and mushrooms are alike very abundant in almost any community in the state; but often the teacher has a considerable problem in the matter of arousing genuine interest in either. Perhaps this is partly due to popular misconception of the serious nature of this study. The insect collector is considered as a child chasing butterflies; the person who eats gill fungi, as an irresponsible person. If biology is to assume the rank which it merits in our high school curriculum it must supplant misconception with permanent interests not merely in insects and mushrooms, but in plant and animal life in general.

At the beginning of the study of insects the making of a chart of the animal kingdom such as I have here usually results in a great many expressions of surprise, and many questions. This chart is based upon the number of described species. Each phylum is in a different color and the vertebrates and arthropods are subdivided into classes. Common names of the classes are probably advisable, representing the classes by one or more prominent types. The making of the chart may well be an assignment and should be either preceded or followed by a field trip in which every animal encountered including homo sapiens be placed in its proper group. Such grouping is not for the purpose of working out any sequence but in order to give first hand acquaintance, that greatest of all arousers of interest, and to impress pupils with the overwhelming number of insects.

I have found that the economic importance of insects is a key to interest. Perhaps this can best be brought out by comparison with other items which might appeal to pupils. This graph, prepared by a high school pupil, compares the estimated damage and benefit from insects in the United States with all of the gold and silver produced in the world, with the total cost of our navy, certain automobile costs, the cost of educating all boys and girls now in school between sixteen and twenty years of age, etc. The chart is for the year 1922. The comparisons are most startling. I have found that this results in a more serious minded attitude toward the study of insects.

Every teacher with the spirit of science will be asking by this time "Where does the important part, the direct study of insects enter such a plan?" It is high time that insect collecting work begin and it should begin with a rush. I have found truck gardens, weed patches, and home gardens the best places to find a considerable number of insects in a double laboratory period. Due to the great number of introduced plants, the area along a railroad usually affords an equal range of insects. Of course the teacher should go over the ground rather carefully before taking the class. I have taken pupils on such a trip with a general understanding that we were going to secure eight "Headliners" or "Insect millionaires" as they are sometimes called.

If the interest aroused in insects is to be permanent, the pupil must become familiar with a number of important insects through repeated association. For this purpose insects may be pinned by the pupils upon colored pictures of plants they affect. For example, on this picture of corn are pinned the corn ear worm, responsible for the loss of such a large part of our sweet corn crop; chinch bugs; cutworms; wireworms; corn root aphids and a number of other important insect pests of this most staple crop. In like manner insect enemies and also protectors may be associated with other plants. Underneath each picture pupils may write the method of injury or protection, brief life histories and control measures. Of course these displays should be kept in a prominent place in the room. For the card on which to pin the insects, I have used here a side of a carton in which cereal breakfast foods are commonly shipped. These usually have corrugated centers. Pins penetrate them readily and at the same time hold firmly. The disadvantage, if desired as a permanent mount, lies in the fact that the specimens are pretty

certain, sooner or later, to be destroyed by other insects; but the cards and pictures are available for next year's class and they have probably served their purpose. If more permanent mounts are desired, the manual training shop can make glass-covered boxes or they can be secured from such sources as Kny-Scheerer Company, and Schmidt.

For this purpose, teacher and pupils need helps in the way of books. For the purpose of general recognition of insects, I do not know of any book equal to Frank E. Lutz's Field Book of Insects. The style is interesting and the plates numerous, many of them colored. So often does the high school teacher find that the book written in a popular style, which will grip high school students, is termed and really is unscientific. Lutz's Field Book of Insects is rated a valuable standard book by trained entomologists, not for the identification of species in many instances, but for general recognition outside the specialist's own field. A few copies of this book in the classroom would be a great stimulus to interest. For life histories and a general discussion of control measures, Sanderson and Pears' Insect Pests of Farm, Garden and Orchard is probably the best book available. It would also be well to have Comstock's Manual for the Study of Insects. I have prepared for distribution a list of books helpful to teachers and pupils in the study of insects, together with publishers, prices, etc. The teacher should also secure a list of the United States Department of Agriculture and of the state publications on insects.

I have in mind other suggestions and devices for securing interest and results in teaching insects. Some of them appear in laboratory manuals and textbooks and I shall only mention one or two of these briefly. Not only may the mouth parts of insects be studied in action, but their functions are much clearer if each pupil dissects off the mouth parts of some large insect with chewing mouth parts such as a grasshopper. A comparison with such types as dog day cicadas (large species often mistaken for the seventeen-year cicada), and the monarch butterfly is very interesting. After dissection, the mouth parts may be glued on a piece of heavy paper and kept in a small cardboard box in the student's desk or on the wall for reference. A most interesting study of the tracheary respiratory system of an insect can be made by boiling some large insects such as grasshoppers in KOH or NaOH after which only the tracheae and exoskeleton remain. For rearing insects through the entire

life cycle, among the most satisfactory are fruit flies, house flies, and the cabbage butterfly. At any rate do not bring in the grubs of passalus cornutus as I once did, only to find out that the life cycle covers a period of about six years. A cabbage plant may be set in a box of dirt and kept in the classroom where all of the stages of metamorphosis of the imported cabbage worm can be watched.

I am fully aware that these suggestions have covered only certain aspects of the study of insects, but I hope in the twenty minutes allotted me to also offer a few suggestions along the line of utilizing mushrooms as a means of securing permanent interest in biology.

I had hoped to prepare a collection of mushrooms for this meeting, but due probably to the rainy summer they spored earlier this year and are consequently less abundant than usual at this time. There is little difficulty, however, in finding mushrooms for study the first two months of the school term and, although the number of species is less, they are fairly abundant in the spring. Because of their relatively large size they are an excellent type of fungi for use in the high school biology. Interest in biology may be stimulated through a mushroom exhibit and a trip to collect edible mushrooms. In the small school this may well take the form of an all school trip with a careful inspection of baskets for nonedible species. If you have never conducted such a trip you will be surprised at the large number of students not enrolled in biology who will bring mushrooms into your biology laboratory for a long period following the trip. Of course, it is a great stimulus to pupils in the biology classes.

Through a mushroom display I attempt to teach the importance of accurate observation. A deadly amanita may be placed by the side of a white lepiota with a sign asking, "What is the difference?" I have placed a nonedible entaloma adjacent to a delicious pluteus cervinus, both of which are pink-gilled and pink-spored and by them a card saying, "Can you believe the rule you often hear: The pink ones are good?" There can be no doubt but that there is much need for emphasizing such cautions, and for the need of replacing heresay with specific information. My attention was very strongly called to this fact by an experience this summer. While at Turkey Run State Park in Indiana with a specialist on the hismer fungi we found a rather rare mushroom which had only been reported from this region once or twice. While returning with the specimen we

met a group of people who asked if it were edible. Receiving an affirmative answer, they immediately asserted their intention of going up on the hill to get some of the same kind. None of them evidenced knowledge of any species of mushrooms. We had on this same hill just finished digging up some amanitas. What difference did it make? They were all white.

The course in high school biology should add interest to the home life, to pupils' outings, etc. He will continue to observe mushrooms if he but learns to know positively a few edible forms. The teacher should emphasize the slogan, "Never eat a mushroom unless you know the species." Pupils should come to feel that it is not to be eaten even though they know it is not any described species of amanita, a green spored lepiota, or a deceiving cleitocybe. Students will soon come to recognize the large puffballs, calvatia; the morels; the inky caps; the three common agaricas, and certain other forms.

Good books for the help of the teacher and the pupils in studying mushrooms are not so numerous; but there are some which every school should have. Publication 26 of the Michigan Geological and Biological Survey (Biological Series 5), Kaufman's Agaricaceae of Michigan, is sold at cost and is probably the most complete reference for the gill fungi. Overholts' the Polyperaceae of the Middle Western United States, Washington University Studies, July, 1915, is perhaps the best reference for the soft, annual shelving fungi. There are a few other helps which may be obtained; the references for which I have listed here.

Atkinson, George F.—Mushrooms. Henry Holt & Co. New York.

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Kellerman, W. A.—Mycological Bulletins (containing descriptions of mushrooms). Ohio State University, Columbus, Ohio.

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McIlvane.—One Thousand American Fungi, Bobbs-Merrill Co., Indianapolis, 1910.

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THE STATUS OF THE BIOLOGICAL SCIENCES IN THE ACCREDITED HIGH SCHOOLS OF THE STATE OF WASHINGTON.

By FRANK K. FOSTER,
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As far as the writer knows, there has never been any attempt to ascertain the current practices in the offering of the biological sciences in the accredited high schools of the state of Washington. There is no concrete evidence to show the extent of training of the teachers instructing in the biological sciences and the teaching combinations, or the points of emphasis in the biological sciences offered. Pursuant to a felt need, it was deemed advisable to secure evidence of the conditions obtaining in the high schools of the state. In order to obtain the facts, a questionnaire was sent out to the four-year accredited high schools of the state of Washington, asking them to indicate their student and teacher enrollments, their offerings in the biological sciences, the preparation of the biological science teacher and his teaching combination, and the texts, teaching phases and materials employed in biological science instruction.

In response to the questionnaire, returns were received from 155 four-year accredited high schools of the state. As the replies represent 78.8 per cent of the high schools, coming from large, intermediate and small size schools, the findings will probably be representative of all high schools of the state. Of the 155 replies, fifteen were from high schools in which there were more than thirty teachers and includes all of the high schools of this size in the state. Twenty-six replies came from high schools with eleven to thirty teachers and one hundred fourteen came from high schools in which there were ten teachers or fewer. Throughout the reading of this study the above mentioned groups will remain constant and be referred to as "Groups I, II and III, respectively."

1. DISTRIBUTION OF SCHOOLS AND PUPILS BY GROUPS.

The most salient aspects of the student enrollment in the high schools of Washington are described in the following table:

TABLE I.

NUMBER AND PER CENT OF PUPILS ENROLLED IN EACH YEAR OF HIGH SCHOOL IN THE THREE GROUPS OF SCHOOLS SEPARATELY AND COMBINED.

Group	No. of Schools	Freshman No.	%	Sophomore No.	%	Junior No.	%	Senior No.	%	Total No.	%
I	15	9627	38.4	6317	25.2	4904	19.6	4207	16.8	25055	54.9
II	26	3456	38.5	2354	26.2	1699	18.9	1452	16.4	8961	19.6
III	114	4010	33.8	3260	27.7	2614	22.0	1898	16.5	11782	25.5
Totals	155	17093	37.2	11931	26.0	9217	20.1	7557	16.7	45798	

The preponderance of the small number of large schools in Group I is readily noted. The fifteen schools in this group represent only 9.7 per cent of the schools reporting. However it is astounding to note that 54.9 per cent of the total high school enrollment is receiving instruction in this small per cent of the schools. Reference to Group II finds 16.77 per cent of the schools reporting among the medium size schools and this small group enrolls 19.6 per cent of the total high school enrollment. No less striking is the preponderant number of schools in Group III. Of the 155 schools replying to the questionnaire, 114 or 73.5 per cent were from the small schools of Group III. Though this group represents almost three-fourths of the schools reporting, it is highly significant to note that the group enrolls just one-fourth of the student population, or 25.5 per cent. Instead of great variation between groups in per cent of enrollment, there is practical conformity in the same years for all groups separately and combined. The freshman enrollment in Group III falls short of the distribution of the other groups, but a balance is established by a slight increase over the other groups in the sophomore and junior years.

The distribution of pupils among the three groups of schools in such disproportionate numbers is largely due to the geographic and industrial conditions that favor the establishment of a relatively small number of large cities on the one hand and the large number of small communities on the other. The advantages derived from consolidation have not yet reached all communities sparsely settled.

2. Enrollments and Distributions of Teachers.

In order that the reader may obtain a comprehensive perspective of the teacher enrollment in each group of schools and the number and per cent of teachers who are teaching biological sciences, the following table is introduced.

TABLE II.

	Group I (Over 30 teachers)	Group II (11-30 teachers)	Group III (10-fewer teachers)	Total
Total number of teachers in the high schools.	909	414	667	1990
Per cent of all teachers in all high schools.	45.7	20.8	33.5	100
Number teaching biological sciences.	32	25	87	144
Per cent of teachers teaching biological sciences.	3.5	6.0	13.0	7.2

If we recall the figures on student enrollment, we see that 54.9 per cent of the total enrollment has 45.7 per cent of the teaching force. In Group I there are 909 teachers in the fifteen schools. Thirty-two of the 909 teachers are teaching biological sciences. Taking Group II we find 16.77 per cent of the student enrollment and 20.8 per cent of the total teaching force. Regarding Group III, the smaller schools, one-fourth of the student enrollment and one third of the teaching force is represented. In this instance there are many of the teachers instructing in three to six subjects as shown in Table 8. This accounts for the apparent large per cent of teachers giving instruction in biological sciences. If the story concerning subject combinations in Table 8, especially in Group III, were not so indicative of the extensive and inharmonious groups of subjects that the average teacher is required to teach, we might conclude too readily that the students of the smaller high schools were highly favored by a greater proportionate number of teachers of biological sciences. Taking the number of teachers in all of the high schools we find 7.2 per cent are instructing in the biological sciences.

3. Sex of Teachers of Biological Sciences.

Current opinion has often expressed the idea that more men prepared to teach the biological sciences than women. In contradiction to this hypothesis, the two groups of larger schools displayed almost a balance of sex among teachers of biological sciences. The disproportionate number of men and women in the smaller schools (thirty-six men and fifty-one women teaching biological sciences in schools of Group III) is probably due to the greater number of women going out to teach in the smaller high schools. There seems to be no specific evidence that either more men or more women prepare to teach biological sciences.

4. Position of Biological Sciences in the Curriculum.

Many of the subjects offered in the high school curricula have, seemingly, a well established and permanent place in the course of instruction. In an effort to ascertain whether the biological sciences held such a position, the reports of the state high school inspector for the years 1920-21 and 1921-22[1] were secured. The returns from the 155 high schools in the present study were appended and the following table evolved for comparative purposes.

TABLE III.

NUMBER AND PER CENT OF PUPILS ENROLLED IN EACH AND ALL BIOLOGICAL SCIENCES FOR THE YEARS 1921, 1922 AND 1923.

Year	Total enrollment	Biology No.	Biology %	Botany No.	Botany %	Zoology No.	Zoology %	Physiology No.	Physiology %	Total No.	Total %
1921	47804	1604	3.3	2673	5.5	1061	2.2	994	2.1	6332	13.2
1922	54588	2287	4.2	2287	4.2	1116	2.0	1118	2.0	6808	12.4
1923	45798	2213	4.8	2605	5.6	615	1.3	480	1.0	5911	12.9

Since the figures for the two previous years involve returns from all of the high schools of the state, the totals for those years are in excess of the totals for the year 1923. This is due to the fact that the present study represents only 78.8 per cent of the four-year accredited high schools of the state, while the reports for the two preceding years include all of the high schools accredited for one, two, three, or four years. Following the listing of enrollment in each biological science is the per cent of the total enrollment taking the science that year. In the case of biology, the percentile increase is to be noted in progression from year to year. The per cent of students enrolled in botany appears to be more uniform from year to year. Zoology has suffered rapid displacement in the biological science offering and physiology has been treated in similar fashion. Biology and botany carry equal honors in claiming the largest part of the students enrolled in biological sciences for the years enumerated.

The tendency for the biology course to displace the other biological sciences is not local and peculiar to Washington. A study made in Minnesota[2] reveals the same tendency and throws some light on the fundamental causes back of the progressive movement of biology among the biological sciences in the high school curriculum.

"1. General biology is a course embodying the essentials of all the biological sciences with much of the detail left out. Hence,

"2. Greater economy of time and teaching force in the crowded curricula of the smaller schools especially.

"3. Since the life processes are fundamentally the same in plants and animals, this fact can be better shown in a general course.

"4. Greater correlation between the various biological sciences can be effected through a general course.

"5. General biology is practical, broad in its scope, and less technical than either zoology or botany, and therefore better adapted to high school work."

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[1]Reports of state high school inspector. Reports of 1920-21 from 393 high schools, 1921-22 reports from 421 high schools, 1923 figures from 155 high schools in Present Study.

[2]The Biological Sciences in the Minnesota high schools—A. M. Holmquist. School Science and Mathematics, February, 1922, p. 169.

5. Offerings and Enrollments in Biological Sciences.

It seems opportune to throw some light upon the status of the biological science offering and the enrollments in the various biological subjects offered in the high schools.

TABLE IV.

Number of Schools Offering Each Biological Science, the Number Offering no Biological Science, and the Total Enrollment in Each for All Groups Separately and Combined.

Group	Number of schools reporting	Number of Schools Offering Biology	Botany	Zoology	Physiology	Number offering none
I	15	4	13	11	7	0
II	26	20	6	2	3	2
III	114	43	44	2	12	31
Total	155	67	63	15	22	33

Group	Number of schools reporting	Number of Students Enrolled Biology	Botany	Zoology	Physiology	Total enrollment
I	15	371	1739	536	232	2878
II	26	873	196	41	77	1187
III	114	969	670	36	171	1846
Total	155	2213	2605	613	480	5911

Particular attention is called to the situation of biology compared with the frequency of botany. Even in the large schools where special courses in single biological sciences can be offered to great advantage, 26.6 per cent of the schools offer a course in biology. The total number of students taking biological sciences in Group I represents only 11.0 per cent of the total enrollment in that group of schools, which is not a very good showing considering the range of electives in the larger schools. Most all the biological sciences are included in the offering of the larger high schools. A consideration of Group II reveals the fact that botany, zoology and physiology have lost ground in favor of the more general course. With 77 per cent of the schools of this group offering biology and 13.2 per cent of the high school enrollment of the group taking some biological science, the condition of the biological sciences is more favorable. Two schools of Group II reported no offering in biological sciences for the current year of 1922-23. Many of the schools of Group III are offering a course in biology. The position of botany holds equal to that of biology at the present time. If we recall the tendency of biology to displace the other biological sciences over a term of years (refer to Table III), it is highly probable that biology is rapidly taking the lead over all the other biological sciences in the offering. The offering of zoology and physiology in the smaller schools is on a decline. The few schools

offering a course in these subjects involve such a small proportion of the high school enrollment in the smaller schools that we predict the ultimate elimination of zoology and physiology from the curriculum of the smaller high schools.

Just what import can be attached to the absence of the biological sciences from thirty-one schools of Group III is an open question. Most of the schools not offering the biological sciences are typical of the median school of Group III. Since the number not offering the biological sciences in this group is 27.2 per cent of the schools in the group, let us take that per cent of the total enrollment of the group. This number amounts to 3,205 and signifies the relative number of students that have no chance to study any of the biological sciences during the given year. Some of those students may receive slight contact with the biological sciences in the course termed general science, which has a large offering in the schools of the state[3]. It is the writer's opinion that such a course does not sanction and render legitimate the elimination of biological sciences from such a large number of schools of the state.

6. Biological Sciences and the Time Element.

The organization of a school curriculum involves many factors. Often the subject matter lacks continuity. Too often there is no general system of progressive achievement. The information supplied in the questionnaires of the present report justifies the conclusion that many of the biological sciences are offered with slight attention to an orderly system of presentation.

The length of the courses in biological sciences conform to a general standard. With the exception of physiology, they are "one-unit"[4] subjects. Physiology was reported in twenty-two schools of the 155 and twenty of these were offering a half-unit course.

Closely allied to the question of unit offerings in the various biological sciences, comes the important element of time devoted to recitation and laboratory periods. The definition of the "unit" by the state board of education rather definitely defines the time element and aids in its standardization. The most frequent recitation plan, except physiology, was the three recitation and two-double laboratory periods per week. In biology there are 62.7 per cent of the schools offering this plan, 63.5 in

[3]For statistical information, refer to School Review, Vol. XXX, No. 6, June, 1922, p. 426. Science in the High Schools of Washington.—Author.)

[4]A "unit" is a subject taught five times a week, in periods of not less than forty-five minutes, for a school year of not less than thirty-six weeks.

botany, 53.3 per cent in zoology and 4.5 per cent of the schools offer the same in physiology. The most frequent practice of recitation other than the three period plan is the five period plan, excluding any laboratory work. It was found that 22.0 per cent of the schools followed this plan in biology, botany 20.6 per cent, zoology 26.6 per cent and in physiology 82.6 per cent. Other recitation period plans in the offering are so varied that no uniform practice, other than the three recitation—two laboratory period and the five recitation plan—are evident. To define the modal practice of laboratory offerings, the frequency of the greater number of schools offering the two-double laboratory periods a week, indicates the trend. In per cents, eighty-eight per cent of the schools teaching biology have two-double laboratory periods a week, 76.2 per cent in botany, 53.3 per cent in zoology and 18.2 per cent in physiology. Thirteen of the twenty-two schools reporting physiology have no allowance for laboratory work in the course.

The general distribution of time for the biological sciences, excepting physiology, can be described as one-unit courses, offered five times a week, three of these periods being devoted to recitation and two-double periods to laboratory instruction. Physiology seems to be a half-year subject being offered five single periods a week without laboratory.

7. Academic Classification of Teachers of Biological Sciences.

Since there are no "standards" to evaluate the various degrees offered by the great number of universities which have trained the biological science teachers of the state, the writer has classified the returns as listed in the following table. "Advanced degree" is described as one or more years of training in addition to the regular bachelor's degree. The bachelor's degree means the degree offered for the completion of the regular four-year collegiate course in universities of recognized collegiate standing, and undergraduates are those individuals who have not yet obtained the equivalent of the bachelor's degree.

TABLE V.

Number and Per Cent of Teachers of Biological Sciences Who Hold Advanced or Bachelor's Degree, and those who are Undergraduates for All Groups Separately and Combined.

Academic Classification	Group I		Group II		Group III		All Groups.	
	No.	%	No.	%	No.	%	No.	%
Advanced	9	28.1	1	4.0	2	2.3	12	8.7
Bachelor's	23	71.9	24	96.0	81	93.1	128	88.8
Undergraduate					4	4.6	4	2.5
Total	32	100.0	25	100.0	87	100.0	144	100.0

Analysis of the table reads as follows: Of the thirty-two teachers of biological sciences in Group I, the larger schools, nine, or 28.1 per cent are holders of an advanced degree, 71.9 per cent have the bachelor's degree and no undergraduates are teaching biological sciences in this group. The per cent of the teachers in Group II with advanced training is greatly reduced. Just one of the twenty-five biological science teachers of this group holds an advanced degree. The remaining twenty-four all reported the equivalent of the bachelor's degree. There were no undergraduates. The conditions of Group III are commendably high. Only 2.3 per cent of the teachers hold an advanced degree, but 93.1 per cent have the bachelor's degree and 4, or 4.6 per cent, are undergraduates. The conditions for all groups combined are listed in the right-hand column. Twelve have advanced degrees and represent 8.7 per cent of the 144 teachers. The major part have the bachelor's degree which totals 88.8 per cent of the teachers, while only 2.5 per cent of the teaching force in biological sciences are undergraduates.

The relative small per cent of undergraduate teachers in the high schools of the state is due to the practice of the principle defined by the State Department of Education, which prescribes the equivalent of a bachelor's degree and a normal diploma[5] as a teaching certificate for high school teachers.

8. TEACHERS TRAINED IN THE STATE.

One of the aims of the teacher training departments of the state's educational institutions is to adequately prepare teachers for the subjects they are to teach in the high schools of this state in particular. Assuming that our training departments prepare teachers for the high schools of this state in particular, the number of teachers now in service who are wholly or partly trained in the educational institutions of the state seems a point in question. These facts are presented in Table VI to show the number and per cent of teachers that are trained in the state and the number and per cent that are trained outside the state for all groups separately and combined.

TABLE VI.

NUMBER AND PER CENT OF TEACHERS TRAINED IN AND OUT OF WASHINGTON FOR ALL GROUPS SEPARATELY AND COMBINED.

	Trained in Washington		Trained out of Washington		No reply
Groups	No.	%	No.	%	No.
I	15	46.9	15	46.9	2
II	18	72.0	7	28.0	0
III	47	54.0	37	42.5	3
All Groups	80	55.5	59	41.0	5

[5]University Normal Diploma—twenty-four quarter-hours in Education.

The reading of the table in respect to the number and per cent trained in Washington shows that less than half of the teachers of biological sciences in the larger schools are trained in the state. Practically three-fourths of Group II are trained in the state and slightly over half of Group III are trained in the state. For all the schools combined, the institutions of the state that have to do with the preparation of the secondary teachers, supply a little over half of the teachers of the biological sciences, or 55.5 per cent, while two-fifths of the teachers of the biological sciences are prepared in institutions outside of the state.

9. Special Academic Training of Teachers.

There is, as we have seen, a high degree of academic training presented by the biological sciences teachers as a whole. Most of the teachers offer training in one to three subjects of sufficient grade to be recognized as a teaching subject. The situation as so far presented illustrates quite a wholesome practice, if training were the only criterion of judgment. But merely giving the prospective high school teacher of biological science specialized training in as many as three teaching subjects will not go a long way in the solution of the teaching problem, especially when the training is confined to the sciences, or to any other single department.

Taking the excellent group represented by the teachers of biological sciences which is adequately trained, let us investigate the number that are actually teaching biological sciences with training in at least one of the four biological sciences. For this purpose the facts are presented in Table VII.

The actual preparation of teachers of biological sciences now in service is presented in terms of a frequency distribution. Scrutiny on the part of the reader will reveal the facts that describe, in the writer's estimation, one of the most important revelations of the present study. The biological science subjects listed across the top of the table are the teaching subjects as reported by the teachers of biological sciences in the high schools of the state. The repetition of the subjects in the left-hand column is the subject of preparation. Taking the teaching subject biology at the top of the page and reading down the major and minor columns, the facts are as follows: Of the sixty-seven teachers of biology, five are majors in biology and twelve are minors, five are majors and one a minor in botany, one a major and one a minor in zoology and one a minor in physiology.

In terms of per cent, only one-fourth have preparation as a major or minor in biology and sixty per cent of these prepared to teach biology have only a minor in the subject.

TABLE VII.

FREQUENCY DISTRIBUTION OF MAJOR AND MINOR SUBJECTS OF PREPARATION OF TEACHERS OF BIOLOGICAL SCIENCES IN THE STATE OF WASHINGTON.

Subject of	Biology		Botany		Zoology		Physiology	
Preparation	Major	Minor	Major	Minor	Major	Minor	Major	Minor
Biology	5	12	6	1	2	1	1	2
Botany	5	1	13	9			1	
Zoology	1	1	3	2	4	3	2	
Physiology		1						
(Majors)	Biology		Botany		Zoology		Physiology	
Agriculture	10		4					
Chemistry	6		5				2	
Economics	2		1					
Education	1		3					
Engineering			1		1			
English	1		2					
Geology			2					
German	1		1					
History	4		2					
Home Economics	4		6				4	
Language							2	
Mathematics	3						2	
Philosophy	1		1					
Physics			1				1	
Science	4		5		1		2	
No Reply	4		2		3		3	
Total	67		63		15		22	

An academic major consists of from thirty-five to forty-five quarter-credits.

An academic minor consists of from twenty to thirty quarter-credits.

Only two-fifths of the teachers of biology show major or minor preparation in one or more of the biological sciences. Without further detail concerning each of the remaining biological sciences, it will suffice to indicate tendencies. Only one-fifth are majors and one-seventh are minors in botany. A number teaching botany are majors or minors in biology or zoology. Zoology ranges slightly higher than botany; one-fourth of the zoology teachers are majors in the subject and one-fifth are minors. Physiology teachers indicate no preparation in the subject. Of all the teachers of biological sciences, but one-half indicate training in one or more of the biological sciences.

The question arises about the remaining half of the biological science teachers and their preparation. These have been grouped in the lower part of Table VII. None of this group indicate any training in any of the biological sciences. Since their majors or minors are not in the biological sciences, the major subject of preparation has been selected and listed in the left hand column.

The frequency in which teachers are teaching one of the biological sciences with a major in one of the subjects listed in the left hand column, appears under the respective teaching subjects at the top of the table. Attention is called to the number having a major in agriculture and those indicating science as a major. No account could be taken of those in the preparation in biological sciences.

An attempt was made to determine the pedagogical preparation of the teachers of biological sciences, but the returns were so incomplete that no interpretation of a specific nature could be made. The state certification law has established a minimal amount of pedagogical preparation for teachers in the state and this is being met in the majority of cases. In ten cases only of those replying to the questionnaire is the amount of pedagogical preparation below the minimum.

10. Teaching Combinations.

The evidence of specialization by the teachers in one, two ,or three teaching subjects has been made clear in the preceding paragraphs. The reader was not warned of certain weaknesses which have been indicated as high standards. One might assume too readily that the high standards attained in preparation were indicative of a wholesome condition in the teaching situation in the high schools of the state. The relative high number in groups I and II that are teaching their major or minor subjects of preparation and the half of Group III that are teaching their major or minor subjects, takes no account of other subjects that appear on their teaching schedule. Pursuant to this weakness the facts assembled in the following table throw some light on the heterogeneous teaching combinations employed with the biological sciences.

TABLE VIII.

Number and Per Cent of Subjects Taught by Teachers of Biological Sciences for All Groups Separately and Combined.

Number of subjects Taught	Group I (Teachers)		Group II (Teachers)		Group III (Teachers)		All Groups (Teachers)	
	No.	%	No.	%	No.	%	No.	%
1	13	40.0	5	20.0	5	6.4	25	17.0
2	12	37.5	10	40.0	16	20.5	38	28.10
3	7	22.5	1	4.0	23	28.2	31	22.2
4			7	28.0	21	26.9	28	20.74
5			2	8.0	12	15.3	14	10.37
6					2	2.7	2	1.48
Total	32	100.0	25	100.0	79	100.0	136	99.94

This table is so constructed as to indicate the number and per cent for all groups of teachers separately and combined who

are teaching one subject, two subjects, etc. The content of Table VIII reads as follows: Of the total number, thirty-two teachers in Group I, thirteen, or forty per cent are teaching one subject, twelve, or 37.5 per cent are teaching two subjects and seven, or 22.5 per cent are teaching three subjects. The other groups read in similar manner. Attention is called to Group III, the smaller schools, wherein the conditions are more striking.

The greatest frequency falls in the three and four subject combinations. Imagine almost three-fourths of the teachers of biological sciences in the smaller schools teaching three or more subjects, and in addition, recall that four schools only are offering two biological sciences. Taking all of the schools in a group, the balance is thrown in a favorable direction by the weight of the larger schools; however, there still remains an astounding per cent of fifty-five teaching three or more subjects. In light of the standard of preparation to teach biological sciences and the range of subject combinations reported by the teachers of biological sciences in the state of Washington there can be little doubt of the inefficiency toward the achievement of the standards claimed for the biological sciences in the high school curriculum.

One who has been in close touch with the situation throughout the state for many years and had to do with the training and recommendation of teachers in many instances, has recently stated in an unpublished report[6] the following description of the situation:

> The grouping of science subjects is in a deplorable condition. Undoubtedly in many schools the principals and superintendents are to blame for the medley, but in the majority of cases it is due to the fact that a very wide range of subjects is required in the small high schools. Changes in staff are so frequent that when vacancies occur the superintendent must fit new teachers in as best he can. In the smaller places, the superintendent who begins his duties in a new place has little or no power in selecting his staff. Frequently, the teachers are selected by the school board without consultation with the superintendent. Often a new teacher begins her work in September when she does not know until the morning school begins what subjects she may be required to teach. I have known teachers who were assigned chemistry or a foreign language after their contracts had been signed. They had never studied these subjects, but went to summer school to get what meager introduction to their subject as could be obtained in the short time. What wonder if their pupils did not become interested in the subject!
>
> A teacher who is required to teach five or six classes a day in that many different subjects, usually unrelated, cannot prepare adequately nor can he be equipped with sufficient information to do the subjects justice.

It may be interesting to note the different subjects being taught

[6]Bolton, Dean F. E., School of Education, University of Wash., Seattle, Wash., Unpublished Study.

in combination with the biological sciences. Thirty-two specific subjects were reported in the questionnaire as teaching combinations with biological sciences. Consider the multiplicity of combinations that could be made with the four biological sciences. Suffice to enumerate certain general tendencies. The practice in the larger schools seems to be rather well defined and the combinations are confined to the pure sciences with one exception. General science presents the greatest frequency combination with any of the biological sciences.

There is not a marked change in the medium size schools of Group II. Mathematics and physics rank first as teaching combinations with the biological sciences and chemistry and general science a close second. It would take an expert mathematician to decipher the heterogeneous combinations that appear in Group III, the smaller schools. Let it suffice to deal with the totals for all groups at this point. Of the 144 teachers of biological sciences, only twenty-three are teaching a single biological science. General science is the most frequent combination with the biological sciences, mathematics second, physics third and chemistry fourth. Though the sciences appear to be the most frequent combination with the biological sciences, this does not justify the fact that three-fourths of the teachers of Group III, the smaller schools, are teaching three or more subjects, nor does it lend itself to agreement that only sixteen per cent of the teachers of the biological sciences in the high schools of the state should be permitted to teach but one subject, while fifty-eight per cent are teaching three or more subjects. The greatest weakness of the whole situation as far as the biological sciences are concerned, seems to center around the fact that few teachers are actually prepared to teach the biological subject in which they are giving instruction. The question lies with the demands of academic departments in training institutions and the lack of co-ordination between departments.

11. Over-Specialization.

Ever since the university has trained teachers for the secondary schools, there has been some question as to the type of training to be offered in order that the teacher will be qualified to assume his place in the high school. Much of the training has been of high standard and the present enrollment of biological science teachers perhaps has sufficient general academic training. It has been the policy to specialize teachers in a given

subject to be called a major and supplement this training with one or two subjects called minors. In this scheme of training it was assumed that the teacher was more or less specialized in one subject and relatively proficient in one or two additional subjects. In biological sciences the practice has been to correlate this training and confine this training to the field of pure science. This policy has certain advantages but it is apt to demand over-specialization, restricting the scope of training and limiting acquaintance in fields equally productive.

To illustrate the point of over-specialization as a defective policy in the training of teachers for the high schools, especially in sciences, the following quotation is introduced. In discussing phases of specialization in science, Doctor Judd writes:[7]

". . . A colleague describing the requirement which a certain university department of physics was attempting to enforce upon graduates of that institution was wanted to secure recommendations to teach physics, says, the department wanted all intending teachers of physics in high schools to take three-fifths of their course in that department. It can be shown, and was shown in the case in question, that in no high school of the state could a teacher be found who taught physics alone. Physics, then, was only a part of the rational part of the preparation of the prospective teacher. Suppose the second subject to be a science. There would be no adequate margin in the student's course for training on a like scale even in the second subject, to say nothing about the general course in literature and history which it is commonly thought a student should pursue.

"Science, as a system of experience, tends to become highly specialized. This is due to the fact that individuals who pursue one system of ideas for a time tend to become limited in thought and action to that one field of experience. The physicist of today is likely to think slightingly of his fellows who work in botany or zoology. The antithesis between applied and theoretical science is sometimes emphasized to the point of bitterness. The only salvation in the situation is that society overcome some of the narrowness of some of its members."

Hampered by this antithesis between departments of instruction, the teachers trained in the past have conformed to the graduation requirements of their major departments and, of necessity, stand forth convicted of over-specialization and human narrowness.

12. Aims in Teaching Biological Sciences.

The position of the biological sciences in the high school curriculum, until recently, have been quite insignificant. Hence, the aims in teaching the biological sciences have not become very well established. It seems apropos to quote some general aims that have been set forth by students of science teaching. The following aims have been defined by the best recognized student of the subject, Professor Otis W. Caldwell, of Columbia:

[7]Judd—Psychology of High School Subjects. Ch. 14, pp. 313.

Biological sciences for universal education must be largely social in their objectives, and secondly, the true motivation of such a study comes not primarily through the laws regulating traffic, but through a keen sense of the life or biological significance of the situation to which these laws relate.[5]

If the value of biological science instruction in the high school is to be conditioned by the aims of instruction, the content of the offering present immediate difficulty. Whether certain values be ascribed to any given aim, or whether they remain contingent values, the content persists as the vehicle of accomplishment.

What can be the content of our biological science offering when practically one-half of our teachers of biological sciences have had no training in the biological subject they are teaching, and when fifty-five per cent of the biological science teachers are instructing in three or more subjects, generally unrelated?

Most authorities have expressed the belief that the texts available for science instruction in the high schools have not met the need. Texts used in the high schools of Washington for biological science instruction were varied. In the respective fields of biological science, the following texts were used with greatest frequency.

Biology	Essentials of Biology	Hunter.
Botany	Practical Botany	Bergen and Caldwell.
Zoology	Textbook of Zoology	Linville and Kelly.
Physiology	Advanced Physiology	Conn and Buddington.

The big complaint concerning the biological sciences in the high schools is the method of presentation of the subject. The average high school teacher makes his presentation of the biological science a hard and fast duplication of his university courses. Until the college courses prepare teachers to present their subjects as high school subjects, this teaching of college biology to the pupils in the high schools of the state will persist.

Conclusions.

The analysis of the status of biological sciences in the high schools of the state of Washington has established facts that demand immediate attention to the reorganization of biological instruction in the high schools of the state.

The one outstanding condition that merits first consideration is the teachers' preparation for the teaching of the biological sciences. The chaos of the subject combinations, especially in the high schools with the small instructional staffs, bears conviction that instruction in the biological sciences is poorly organized,

[5]Caldwell—School Science and Mathematics. Vol. 21, 1921. pp. 114.

ineffectively taught and its educative value, as taught, is of minor importance. Since we have seen on the one hand that the teachers of biological sciences have little preparation in the biological subject they are teaching, and on the other, that the chaotic conditions of subject combinations precludes any attempt to do other than indifferent teaching, one may readily conclude at this juncture that biological science teaching is not fulfilling its mission. As long as the institutions that prepare teachers for the high school continue to prepare them without adequate special training in their teaching subjects, and these should be high school subjects, just so long must we have teachers poorly prepared to teach these subjects.

The situation has been so well described by Doctor Woody that the writer will include a recommendation[9] from his study.

> Our institutions that have to do with the training of high school teachers must train each of them to give instruction not in one subject, but rather in subjects. Knowing, as we do, that almost all the product of these training institutions go first to the traditionally organized smaller four-year high schools with the smaller instructional staff, we must prepare them to give instruction not merely in one or two, but most often in not fewer than three subjects. Some institutions have been doing this for a number of years but too many still proceed in ignorance, neglect or even defiance of the lessons of such facts as have been cited, by requiring such a large number of credit hours in one major subject as to preclude the students making any considerable preparation for teaching other subjects. But merely giving each prospective high school teacher specific academic preparation in as many as three different high school subjects will not go far toward a solution of the problem. With the chaos in subject combinations now being assigned to teachers in our high schools there is little liklihood that if a teacher in training makes preparation in any two or three different subjects, he will be fortunate enough to be permitted to teach those subjects in the high school to which he goes when his period of training is concluded. If no effort is to be made to train teachers in what we may term "standard combinations," or, after training them, to elect them to teach combinations in which they have been prepared, little hope of improvement in the situation may be entertained.

Such facts as are disclosed in the present study urge the need of intelligent cooperation toward standardization of subjects to be taught with biological sciences.

Since the most deplorable conditions are to be found among the smaller high schools of the state, it furnishes a protest against further establishment of small high schools. To a large extent the number of small high schools is a necessity at present, due to the economic conditions that mark the location of the various small communities throughout the state. The time is near when the schools will turn their organization to the form of the junior high school. The findings of the present study present an argu-

[9]Woody—eighteenth Yearbook, double number.

ment in favor of such organization in the high schools of the state. With the inclusion of the two upper elementary grades in the high school organization, the number of students would offer increased advantages and greater specialization of teachers could be effected. The benefits to be derived from such an organization are considered highly advantageous in the establishment of a well organized course of instruction in the biological sciences in the high schools of Washington.

Finally, the lack of continuity, the absence of well defined aims and the inadequacy in preparation of teachers places an obstruction in the way of reorganization. The biological sciences in the high schools is a new problem, yet the experiences of the past have not taught us to meet the changing conceptions of education in a methodical manner.

POTATO BEETLE INVADES EUROPE.

The Colorado Potato Beetle, otherwise and more familiarly known to farmers as the potato bug, has followed in the footsteps of the A. E. F., and established himself in Europe. But, unlike the doughboys, the potato bugs have no return tickets. So firmly are they settled in France that French entomologists despair of exterminating them. "They shall not pass" might stop the Kaiser's army, but no such slogan worried the fighting Yankee bug who, arriving in France sometime during the war, proceeded, figuratively speaking, to "cut himself a piece of cake and make himself at home."

The invasion is looked on with dismay by European farmers. Potatoes form a large part of the diet of the average North European, and as historians well know, it was the abundant potato crops of the war years that helped Germany to hold out so long. Quarantines have been established against France by England and other countries in an effort to keep out the invader, and the Germans are especially on guard against this onslaught on their favorite vegetable.

But the busy bug, which has in the space of fifty years crossed the most of the North American continent and the Atlantic ocean, is hardly to be held at the Rhine. During the war it was seriously proposed by American entomologists to drop potato bugs from airplanes over the fertile fields of the Fatherland, but the project never came to fruition. Now the bugs have taken the matter into their own hands and having been colonized in France through the great volume of wartime shipments of all sorts, they are already chanting their slogan of "On to Berlin."

But if they cross the Rhine they are not likely to stop at Berlin or anywhere else, but to spread generally throughout Europe and Asia, adding another powerful hazard to the risks run by European farmers and giving another illustration of the way commerce has of not only ministering to the needs of man, but also of being of service to his enemies. The gypsy moth, the white pine blister rust, and the corn borer have been brought to America from Europe, and now the potato bug has traveled back along the ways of trade to return with interest the damage caused his native land by his distant cousins of the insect world. —[*Science Service.*

ASTRONOMERS DISCOVER MERCURY TWIRLS RAPIDLY.

By Isabel M. Lewis,

U. S. Naval Observatory.

Observations of the planets made at the Mt. Wilson Observatory during the past year have led to the surprising conclusion that Mercury, the smallest of the planets and the one nearest the sun, turns on its axis rapidly and not in a period of 88 days, equal to that of its revolution around the sun, as has long been believed.

It was found from measurements of spectrograms of Venus, however, that this sister planet of the earth rotates slowly in a period that cannot be less than twenty days. The results for Venus are in accord with the results of a similar investigation made some time ago by Dr. E. C. Slipher of the Lowell Observatory.

Comparisons were made of the radiations from the surfaces of Mercury and the moon and it was found that the temperature of the illuminated side of Mercury is about equal to that of the moon. This is an unexpected result. Mercury is much nearer than the moon to the sun and if it always kept the same side turned toward the sun, as it would if its rotation period were 88 days, then the radiations from its illuminated surface should be much more intense than the radiations from the surface of the moon. The best explanation of the observations seemed to bear that the planet is rotating in a short period. Observations of the radiations from the dark side of the planet also supported this view. Radiation from the surfaces of the moon and Mercury were found to be very high, about 74 per cent, in each case, and this furnished new evidence that these bodies have little if any atmosphere.

Even with a short period of rotation life on Mercury would be an impossibility owing to the absence of any appreciable atmosphere. On Venus even with a long rotation period life may exist for the atmosphere of Venus is as dense as that of the earth, if not denser. Seasonal changes on Venus would be lacking because the axis of rotation of the planet is perpendicular to its orbit. The temperature at any one point on the planet's surface would be uniform throughout the year, intensely hot in equatorial regions, frigid in polar regions, though air currents would do much toward equalizing the extremes of heat and cold.

Mercury is the least observed of the brighter planets. As a result of its nearness to the sun it is lost in its rays most of the time and can only be seen for two weeks or less near the time of its greatest elongation from the sun, and even then it cannot be seen to advantage in high latitudes when the ecliptic makes a small angle with the horizon. It is best seen in the evening in March or April, and in appearance is very similar to the bright star Vega.

Venus has been a brilliant Evening Star in the west for a number of weeks and will continue to be the most conspicuous stellar object in the western evening sky until early in the summer. It is approaching the earth at the rate of about half a million miles a day and is increasing in brightness. On February 15 its distance from the earth was about 110,000,000 miles. Viewed through the telescope it resembles the moon between the first quarter and full. When it reaches its greatest elongation east of the sun on April 21 it will resemble the moon at first quarter and after that date it will gradually assume the crescent form. A month later it will attain its greatest brilliancy while still in the crescent phase and a few weeks later will come into inferior conjunction with the sun and disappear from the western sky, to reappear a few weeks later in the east before sunrise.—[*Science Service*.

LIGHT MAY BE A SERIES OF TINY DARTS OF ENERGY.

What we know as light is not a series of spreading waves in the ether that was supposed to fill all space, neither is it a rain of infinitesimal particles shot off from the light-giving body, as was once thought; but it is probably a rain of tiny darts of energy, acting in some ways like waves and in others like particles, Dr. W. P. Davey of the research department of the General Electric Company said in an address before the Franklin Institute in Philadelphia.

Each of the older theories explained some of the facts that were known about light, but not all of them, the speaker said. A study of the structure of some crystals made the theory that light was a rain of tiny particles extremely improbable. The old theory of waves spreading out from the source like those from a stone dropped in a pond, failed to explain why it is that when a ray of light falls on a clean metal surface, electrons of the metal try to jump out of it with the same velocity that the light rays strike it.

A combination of the two theories has been proposed by Dr. L. Silberstein of the laboratory of the Eastman Kodak Company, Dr. Davey said. He thinks of light waves as tiny search-light beams which he calls "darts." These are supposed to be electro-magnetic waves which do not spread out in all directions but which transmit the energy from the electron giving the light in beams of definite size which travel out in straight lines. The reason light appears to come from all directions is that there are so many electrons in a radiating body that they shoot out light "darts" in all directions.

Just how an electron gives out light nobody knows, Dr. Davey said. One theory conceives of light being given out by the vibrations of electrons on the outside of atoms while vibrations of those on the inside cause X-ray radiation. The other theory conceives of an atom as a sort of whirling solar system of electrons revolving around the nucleus and that light results when an electron skids and slips from one sort of orbit into another. Both theories account for some of the observed facts.—[*Science Service*.

SCIENCE CONFIRMS INDIAN TRADITION.

An ancient Indian tradition handed down for centuries has been confirmed by John P. Harrington of the Smithsonian Institution, as the result of archaeological explorations near Humboldt Lake, Nevada. He had heard from an old Payute chief a story of how his people, centuries ago, had driven the Saitekare tribe into a cave near the lake and then exterminated them all without mercy. Inquiry revealed the existence in the cave of quantities of bones and objects of Indian manufacture, showing that the tribe had died fighting with their belongings piled about them.

Commenting on this find and on the work of American anthropologists in establishing the unity of prehistoric human life on the American continent, Mr. Harrington says:

"The greatest triumphs of the last decades of anthropological research in this country have been the dissipating, one by one, of the earlier beliefs and theories regarding the existence of races which preceded the Indians and were distinct from them, and the slow accumulation of an overwhelming mass of evidence that all the remains of man on the American continent are Indian in origin. The Indians are a single people, an offshoot of the Mongoloid race, which held those parts of the Old World adjacent to the great island of America.

The race of Mound Builders, accepted by our early scientists, has proved to be a phantom. James Mooney, ethnologist of the Smithsonian Institution, in 1886 and subsequently visited the primitive Eastern Cherokees who remained in their native habitat in the Southern Alleghanys after the main body of the tribe had been transplanted to the Indian territory in Oklahoma. He found aged individuals who retained a knowledge of the mounds, and supplied him with elaborate details as to the method of their construction. The mounds of that region were erected by the ancestors of the Cherokees because it was the custom to do so. The mounds were used as vantage eminences for villages and for burial of the dead.

"Similarly, the spectre of the Toltecs and Mayas as a distinct people from the modern Indian, and again as having a distinct civilization severed from that of existing tribes in Mexico and Central America and related to the Egyptians or Assyrians, has been shattered by the scrutiny of recent years. Intensive work among the remaining fragments of people in that region reveals that the builders of the temples and the priests who prepared the marvelous codices and inscriptions, which offer such contrast to the dismal jungles in which they are found, were nothing more than the ancestors of the present day peons, and not so very far back either.

"In the Southwest, the great desert region of New Mexico, Arizona, Colorado, Utah and Nevada, a similar problem to that of the Mound Builder and Mexican regions, today awaits solution. The treasures of the cliff habitations, where in many cases even the houses and their furnishings are extant, remain to be connected definitely with this or that present-day Indian tribe.

"In view of the fact that these western relics, although certainly Indian, have proved so difficult to tie with definite modern tribes, the recent discovery of the material remains of the Saitekare in the very cave where Payute tradition said they fled, at the eastern end of Humboldt lake, Nevada, is gratifying."—[*Science Service*.

The rare earth thorium forms the chief chemical constitutent of the mantles used for incandescent gas burners.

CORRECTION IN PRESS MEMORANDUM ON PLATINUM AND ALLIED METALS IN 1922.

In a press statement issued by the Department of the Interior on platinum and allied metals, which was prepared by J. M. Hill, of the Geological Survey, released on June 20, 1923, it was stated that refiners reported the purchase of seven ounces of crude platinum from Idaho. The reports from placer mines to the Geological Survey did not, however, report any production of platinum in Idaho in 1922 and further investigation of refineries' purchases in 1922 shows that no platinum was produced in Idaho.—[*U. S. Geol. Survey.*

GEOLOGISTS INVADE ARCTIC TO SURVEY HUGE NAVY OIL FIELD.

The first reconnaisance survey of the Navy's largest petroleum reserve, located in northern Alaska on the slopes of the Arctic Ocean, is about to be begun by the U. S. Geological Survey. It will involve a trip across central Alaska in midwinter, the expedition expecting to "jump off" from Tanana into the unexplored and desolate wilderness to the northwards about March 1. The final objective will be Pt. Barrow on the Arctic coast which will be reached after a journey of about 1,000 miles by dog sled and canoe.

The area to be examined, in which the oil reserve is located, is bigger than the state of Maine, comprising 35,000 square miles of practically uncharted wilderness that includes lofty mountain chains and vast silent stretches of tundra. The reserve which was created by Executive order last February is an irregular tract that extends for nearly 300 miles along the coast of the Arctic Ocean, with Pt. Barrow as its most northern point, and runs inland in places for more than 200 miles. It is thought that all this area may contain valuable minerals besides the oil.

A midwinter start has been chosen because traveling in the north is easier when the snow is still on the ground and streams are frozen. The early start will also give sufficient time to carry through the work. The expedition must be entirely self-sustaining for about six months, requiring the freighting of supplies by dog sled for 400 miles even before the reserve is reached. Supplies weighing more than four tons, and including food, instruments, and even canoes, will be carried.

The route from Tanana will be over the mail trail to the Koyukuk River, a northern tributary of the Yukon, up the Koyukuk to the Alatna, one of its own tributaries, and then 150 miles up that stream to the northern limit of timber where headquarters camp will be established, well within the Arctic circle. From this point the advance party will explore the neighboring mountains for a pass while waiting for the freight sleds to catch up with them.

The whole expedition will then cross the mountains, which form the southern boundary of the oil reserve, and will explore their northern slopes. Spring will then be well under way, the streams will be opening, and the party will divide into two sections, each taking a separate route to the Arctic Ocean, hundreds of miles to the north. This part of the journey will be made by canoe, one party expecting to descend the Meade river, the lower 120 miles of which was ascended and mapped by a Geological Survey party last summer.

During the last 700 miles of the journey, the expedition will be in a country where there is not a stick of wood as big as a pencil, and it must carry all its fuel which will be kerosene oil. It is hoped to help out the commissariat with game such as moose, mountain sheep, ptarmigan, and caribou. Fish and little black bears may furnish additional delicacies, especially for the hungry dogs which are expected to consume at least a ton and a half of food.

The party will be in command of Dr. Phillip S. Smith, geologist, who is familiar with the region just south of the oil reserve, and who is already on his way. The other technical members of the expedition are J. B. Mertie and William T. Foran, geologists; Gerald Fitzgerald, and R. K. Lynt, topographic engineers, and several assistants.—[*Science Service.*

In cold weather the birds' greatest enemy is the length of the night which means a long fast for the day-feeding kinds.

MINING WITH SMOKE.

Mexicans working in a lead mine in Chihuahua have found a new use for cigarettes. The mine consists of a series of caves along the sides and bottoms of which lead and silver ore in paying quantities is found. The miners have noticed that smoke from their cigarettes is sucked through cracks in the rocks at certain points. By drilling in the wake of the smoke, they break through into another cave. This method of tracing the ore has been followed through a series of caves and still the smoke passes out at the end of the last cave discovered, indicating that there are other caves ahead.

SUN'S AGE AT LEAST TWO BILLION YEARS.

The age of the sun has been fixed at something between two billion and three billion years by Prof. Walter Nernst after research announced at a meeting of the Society for Industrial Progress. The estimates are based in part on the rate of decomposition of radio-active elements, and in part on deduction from Einstein's theory of relativity concerning the relation between mass and energy.

Early estimates set the age of the sun as low as ten million years, but geologists showed this was too short to allow for the erosion and other changes observed in the crust of the earth since it became solid. The radioactive decomposition of uranium to lead is a more accurate cosmic clock and this indicates that the solid crust of the earth has existed for at least one and a half billion years. According to Nernst, the sun while getting past middle age is still good for 400 million years, after which a crust will form on its surface and life such as we know it will cease upon the earth.—[*Science Service.*

COURSES ANNOUNCED FOR THE SUMMER OF 1924 AT THE UNIVERSITY OF CHICAGO.

The Summer Quarter of 1924, University of Chicago: First Term, June 16 to July 23; Second Term, July 24 to August 29.

The following courses in Mathematics are announced: By Professor G. A. Bliss, Functions of a Real Variable, 4 hours; Thesis Work in Analysis, By Professor L. E. Dickson, Theory of Numbers 1, 4 hours; Thesis Work in Number Theory. By Professor H. E. Slaught, Elliptic Integrals, 4 hours; Differential Equations, 4 hours. By Professor M. Frechet, Theory of Abstract Sets, 4 hours; Theory of Probability, 4 hours. By Professor E. T. Bell, General Theory of Numbers, 4 hours; Theory of Equations, 4 hours. By Professor F. R. Moulton, Functions of Infinitely Many Variables, 4 hours; Analytic Mechanics II, 4 hours. By Associate Professor J. W. A. Young, Differential Calculus, 5 hours; College Algebra, 5 hours. By Assistant Professor E. P. Lane, Synthetic Projective Geometry, 4 hours; Plane Analytic Geometry, 5 hours. By Doctor Mayme I. Logsdon, Introduction to Higher Algebra, 4 hours; Integral Calculus, 5 hours.

PRIZE CONTEST OPEN TO ALL HIGH SCHOOL STUDENTS FOR POSTERS ON HEALTH SUBJECTS.

Hygeia, a magazine of health published by the American Medical Association, offers a series of forty-nine prizes for posters on any health subject submitted before May 31, 1924. The Jury of Award will be; Surgeon General Hugh S. Cumming, U. S. Public Health Service; Mr. John T. McCutcheon, Cartoon Artist for the Chicago Tribune; President William B. Owen, Chicago Normal College, Ex-President of the National Education Association.

Full information concerning this contest, list of prizes, rules of the contest, etc., can be obtained by writing to the Poster Editor of *Hygeia*, Care of American Medical Association, 535 North Dearborn Street, Chicago, Illinois.

A conference of city supervisors of home economics in the United States has been called by the United States Commissioner of Education to be held in Washington, April 22, 23, and 24. Headquarters will be the auditorium of the Department of the Interior. The chairman of the conference will be Miss Emeline S. Whitcomb, Specialist in Home Economics, Bureau of Education.

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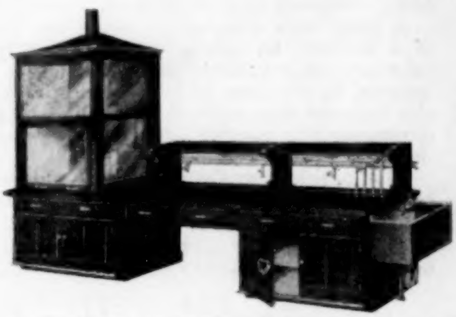

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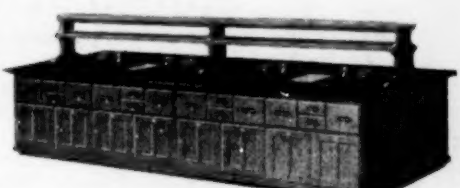

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PROBLEM DEPARTMENT.

CONDUCTED BY J. A. NYBERG,
Hyde Park High School, Chicago,

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and solve problems here proposed. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The Editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to J. A. Nyberg, Hyde Park High School, Chicago.

LATE SOLUTIONS.

811. Michael Goldberg, Philadelphia, Pa.
811, 812. N. H. Mewaldt, State Normal School, Dickinson, N. D.

SOLUTIONS OF PROBLEMS.

816. *Proposed by J. F. Howard, Brackenridge H. S., San Antonio, Texas.*

A man buys a house for c dollars, payable in monthly installments of p dollars, the balance of the monthly installment (after paying the interest) being applied to a reduction of the principal. The debt bears interest at the rate of r per cent per annum. Find a formula giving the balance due after n monthly payments. Also find a formula to determine the number of monthly installments required to pay off the debt.

This problem was submitted to the proposer by a building and loan association which makes extensive loans of the kind described.

Solved by C. N. Mills, Teachers' College, Aberdeen, S. Dak.

The amount due after the first payment is: the original debt, c, plus a month's interest, less the payment p. Or,

$$c\left(1+\frac{r}{12}\right)-p$$

The amount due after the second payment is similarly found by multiplying the preceding debt by $(1+r/12)$ and subtracting p. Or

$$c\left(1+\frac{r}{12}\right)^2-p\left(1+\frac{r}{12}\right)-p$$

The amount due after the nth payment is

$$c\left(1+\frac{r}{12}\right)^n-p\left[\left(1+\frac{r}{12}\right)^{n-1}+\left(1+\frac{r}{12}\right)^{n-2}+\ldots\ldots\ldots\ldots\ldots 1\right]$$

$$\text{or } c\left(1+\frac{r}{12}\right)^n-\frac{12p}{r}\left[\left(1+\frac{r}{12}\right)^n-1\right]$$

$$\text{or } \left(c-\frac{12p}{r}\right)\left(1+\frac{r}{12}\right)^n+\frac{12p}{r}$$

To find the number of payments necessary to pay the debt, equate the above expression to zero and solve for n:

$$\left(1+\frac{r}{12}\right)^n=\frac{12p}{12p-rc}$$

Taking the logarithms of both members gives

$$n\log(1+r/12) = \log 12p-\log(12p-rc), \text{ or}$$

$$n=\frac{\log 12+\log p-\log(12p-rc)}{\log(12+r)-\log 12}.$$

Illustration: If c = $5,000, r = 6%, p = $50, n = 5, then the balance due is $4,873.74 and the debt will be paid in 11 years, 8 months.

Also solved by *J. Murray Barbour, Ardmore, Pa.; George H. Flamson, Itasca Junior College, Coleraine, Minn.; Michael Goldberg, Philadelphia, Pa.; Lindsay C. Marshall, Cambridge, Md.; E. Rae, San Jose, Cal.; W. W.*

Wallace, Sacramento Junior College, Cal.; and the *Proposer.* *E. Rae* made an extensive analysis of the problem under various kinds of payments and their advantages and disadvantages over paying rent to a landlord. If space permits we hope some day to print this in full.

817. *Proposed by C. E. Githens, Wheeling, West Virginia.*

Find the sum to n terms of:

$$5,\ 55,\ 555,\ 5555, \text{ etc.}$$

I. *Solved by J. Murray Barbour, Ardmore, Pa.*

The given series suggests the repeating decimal .5555 · · · · · whose limit is 5/9. If 5/9 be multiplied by 10^n the product will be one of the terms in the series plus 5/9. Hence the given terms may be written as

$$\frac{5\cdot 10-5}{9},\ \frac{5\cdot 10^2-5}{9},\ \frac{5\cdot 10^3-5}{9}, \text{ etc.}$$

The sum of a geometrical progression is $a(r^n-1)/(r-1)$. In this case $a = 50/9$, $r = 10$. $\therefore S = 50(10^n-1)/81$. Since 5/9 must be subtracted from each term, the desired sum is

$$50(10^n-1)/81-5n/9, \text{ or } 5[10^{n+1}-9n-10]/81$$

II. *Solved by John Ankebrant, River Rouge H. S., Mich.*

The sum of n terms of the series 1, 11, 111, 1111, · · · · · · is the number formed by writing n digits in regular order starting with 1, as 1234567890123 · · · · · (n digits).

The sum of n terms of the original series will be the number so formed multiplied by 5.

III. *Solved by J. F. Howard, San Antonio, Tex.*

Letting $t = 10$, we can write:

$$S = 5+(5t+5)+(5t^2+5t+5)+\cdots\cdots(5t^{n-1}+5t^{n-2}+\cdots\cdots 5)$$

$$= \frac{5(t-1)}{t-1}+\frac{5(t^2-1)}{t-1}+\frac{5(t^3-1)}{t-1}+\cdots\cdots\frac{5(t^n-1)}{t-1}$$

$$= \frac{5t(t^n-1)}{(t-1)^2}-\frac{5n}{t-1}=\frac{5[t(t^n-1)-n(t-1)]}{(t-1)^2}$$

$$= \frac{50(9999\cdots\cdots \text{to } n \text{ digits})-45n}{99}$$

$$= \frac{50(1111\cdots\cdots \text{to } n \text{ digits})-5n}{11}$$

IV. *Solved by Elmer Schuyler, Bay Ridge H. S., Brooklyn, N. Y.*

By the usual methods we can derive the general formula

$$S = a[r(r^n-1)-n(r-1)]/(r-1)^2$$

but the following method gives a simpler result for this problem. Let 1_n mean a number of n digits all of them 1's.

$$\text{Then}\quad S = 1+11+111+\cdots\cdots 1_n$$

$$10S+n = 11+111+1111+\cdots\cdots 1_{n+1} = S-1+1_{n+2}$$

$$\therefore 9S = 1_{n+2}-(n+1)$$

For the given series, the sum is $5[1_{n+1}-(n+1)]/9$ which may be stated as the rule: To find the sum of n terms, subtract $(n+1)$ from the next higher $(n+1)$st term, and multiply by 5/9. For example,

$S_1 = 5/9(11-2)$. $S_2 = 5/9(111-3)$. $S_3 = 5/9(1111-4)$.

Also solved by *Norman Anning, T. E. N. Eaton, Redlands, Cal.; Michael Goldberg; Lindsay C. Marshall, Cambridge, Md.; Nelson L. Roray, Metuchen, N. J.; Irma L. Smalley, Ogdensburg, N. Y.; W. W. Wallace;* and the *Proposer.*

818. *Proposed by C. E. Anton, Mesa, Arizona.*

Prove the law which states: To divide by a fraction invert the divisor and multiply.

Solved by Norman Anning.

1. Admit that $m \div n$ can be written $\dfrac{m}{n}$.

2. Admit that $\frac{m}{n} = \frac{mp}{np}$ where p is any number not zero.

3. Admit that $\frac{ad}{bc} = \frac{a}{b} \cdot \frac{d}{c}$.

Proof. $$\frac{a}{b} \div \frac{c}{d} = \frac{\frac{a}{b}}{\frac{c}{d}} = \frac{\frac{a}{b} \cdot bd}{\frac{c}{d} \cdot bd}, \text{ (by 1 and 2)}$$

$$= \frac{ad}{bc} \text{ (by 2)} = \frac{a}{b} \times \frac{d}{c} \text{ (by 3)}.$$

Also solved by *Theodore Darby, Redlands, Cal.; T. E. N. Eaton; J. K. Elwood, Philipsburg, Mont.; Michael Goldberg; J. F. Howard; N. L. Roray; J. C. Scarborough, Santa Anna, Tex.; W. W. Wallace.*

819. *Proposed by J. J. Sheekey, St. Joseph's Normal Institute, Ammendale, Md.*

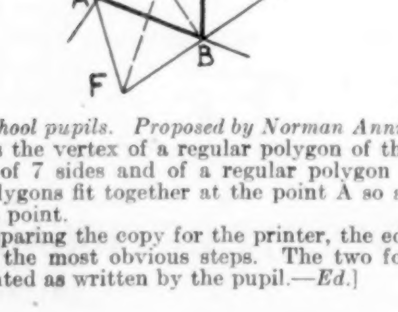
Bisect the exterior angles of a given triangle and join the vertices of the triangle thus formed to the opposite vertices of the given triangle. The lines thus drawn are the altitudes of the triangle formed by the bisectors of the exterior angles.

Solved by Myra E. Wasser, Burlington H. S., Iowa.

Since D, E and F are on the bisectors of the exterior angles, they are equidistant from the sides of the angles, that is, from the sides of the given $\triangle$ABC. Therefore they must lie on the bisectors of the interior angles of $\triangle$ ABC; hence, DB, AE, and CF bisect the interior angles at A, B and C.

Call $\angle$ FBA $= x$, $\angle$ ABD $= y$, $\angle$ DBC $= z$, $\angle$ CBE $= w$. Then $y = z$ because DB bisects $\angle$ ABC; and $x = w$ because each is half of two vertical angles. Also $x+y+z+w = 180°$. From these equations: $x+y = z+w = 90°$. Hence DB $\perp$ EF; and similarly EA $\perp$ DF and FC $\perp$ ED.

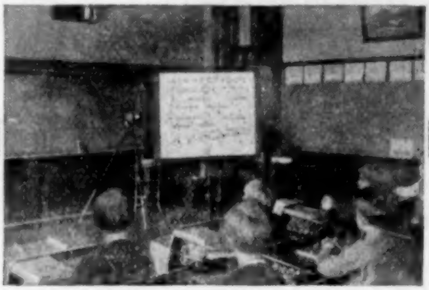
Also solved by *J. Murray Barbour; F. A. Cadwell, St. Paul, Minn.; T. E. N. Eaton; J. F. Howard; L. E. Lunn, Heron Lake, Minn.; R. T. McGregor, Elk Grove, Cal.; N. L. Roray; Irma L. Smalley;* and *W. W. Wallace.*



820. *For high school pupils. Proposed by Norman Anning.*

The point A is the vertex of a regular polygon of three sides and of a regular polygon of 7 sides and of a regular polygon of n sides. Find n if the three polygons fit together at the point A so as to cover all the space around the point.

[Usually in preparing the copy for the printer, the editor contracts the proof and omits the most obvious steps. The two following solutions, however, are printed as written by the pupil.—*Ed.*]



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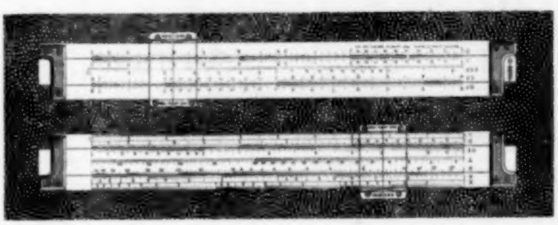

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Drawing Materials, Mathematical and Surveying Instruments, Measuring Tapes

I. *Solved by George Crossley, South H. S., Worcester, Mass.*

Since each angle of a regular polygon equals $2(n-2)/n$ rt. $\angle$s,

$\therefore$ The angle of the equilateral triangle at vertex A = 60°.

The angle of the regular 7-gon at vertex A = 128-4/7°.

and since the perigon equals 360°

$\therefore$ the angle of the regular n-gon at vertex A = 171-3/7°.

Now since a central angle of any regular polygon—i. e., the angle between two successive radii—is a supplement of an angle at the vertex,

$\therefore$ the central angle of the regular n-gon = 8-4/7°.

and there are 360 ÷ 8-4/7 = 42 of these angles about the center. Since each angle subtends a side of the polygon, the regular n-gon must have 42 sides.

II. *Solved by Mazie Urquhart, Redlands, Cal.*

A regular polygon is both equilateral and equiangular.

In an equiangular polygon, each angle is equal to $(n-2)180°/n$ where n equals number of sides.

Then a regular polygon of three sides would have $(3-2)180°/3$ in one angle or = 60°.

Then a regular polygon of seven sides would have $(7-2)180°/7$ in one angle or = 28-4/7°.

Since the sum of all the angles around a point equals 360°, the other angle of the third regular polygon must equal 171-3/7°.

$$\frac{(n-2)180°}{n} = 171\text{-}3/7°$$

$$\frac{180°n-360°}{n} = \frac{1200°}{7}$$

$$1260°n-2520° = 1200°n$$

$$60°n = 2520°$$

$$n = 42$$

Therefore the other polygon must have 42 sides.

Also solved by *Mary Behtz, Harry Boecker, Frances Reppert, Burlington, Ia.; Eugene Desquin, Cambridge, Md.; Mike Wagner, Dickinson, N. D.; Glen Hopkins, Alfred Witte, Hickman Mills, Mo.; Russell Brotemarkle, Lucille Land, Helen Lord, Vera Milton, Northeast H. S., Kansas City, Mo.; Theodore Darby, Carolee Ditzler, Redlands, Cal.; Wilbourn Weaver, Santa Anna, Tex.; Edward C. Drews, Stillwater, Minn.*

Tradition requires that the proof of a geometric exercise be written in two columns, one for statements and one for reasons. It is rather burdensome, however, to do this in a problem involving arithmetical and algebraic work. Of the 17 solutions only 3 used the two-column arrangement. Most of the solutions were written as we might expect the solution of a problem in algebra leading to an equation. From this point of view the best solution was by Theodore Darby who derived the equation

$$\frac{180°(7-2)}{7} + \frac{180°(3-2)}{3} + \frac{180°(n-2)}{n} = 360°.$$

On quite a few of the papers we see the symbol, °, for degrees in the equation. The editor prefers to omit such symbols and regard an equation as a relation involving abstract numbers. Nine of the solutions contained the incorrect statement "All the angles around a point equal 360°."

PROBLEMS FOR SOLUTIONS.

831. *Proposed by M. Freed, Wilmington, Cal.*

Find the center of a circle using compasses only.

[The problem does not state whether or not the radius is known. Can the center be found by compasses only if the radius is not given?—*Ed.*]

832. *Proposed by W. T. Harlow, Portland, Ore.*

In our decimal system of currency the removal of the decimal points does not change the value of any expressed amount of money reduced to cents. For example, removing the decimal point from $90.60 we have 9060 cents. In English money there is only one amount which admits of the removal of the dividing points or units, reducing the figures to farthings without disturbing the expressed value. Find the amount.

833. *Proposed by J. K. Ellwood, Philipsburg, Mont.*

A and B start to walk around a circular path one mile in circumference.

Each reduces his rate one mile per hour at the end of the first hour, and again one mile per hour at the end of the second hour.

They start in the same direction. Twelve minutes after A has passed B the 3rd time A turns and walks in the other direction until 6 minutes after he has met B the 3rd time again, whereupon he turns to his original direction and overtakes B four times more. Find the rate of each if each has walked 3 hours and A has walked 8 miles more than B.

834. *Proposed by F. A. Cadwell, St. Paul, Minn.*

ABCD is a quadrilateral inscribed in a circle. F and E are points on AC such that $\angle ADF = \angle BAC$, and $\angle ABE = \angle DAC$.

Prove that $AF = EC$.

835. *For High School Pupils. Proposed by Betty J. Sharp, pupil at the Miami H. S., Miami, Florida.*

Construct a triangle having given a side, an adjacent angle, and the difference of the other sides when the greater side is opposite the given angle. (Using only material found in the first half year of geometry.)

BOOKS RECEIVED.

Self Improving Business Arithmetic, by Thomas T. Goff, Normal School, White Water, Wisconsin. Pages xv+316. 13x18.5 cm. Cloth. 1923. The MacMillan Company, New York City.

The Literary and Historical Atlas of Europe by J. G. Bartholomew. Pages xiv+254, 11x16.5 cm. Cloth. 1923. J. M. Dent & Sons, New York City.

The Magic of Communication, John Mills, 38 pages. 15x22.5 cm. Paper. 1923. American Telephone & Telegraph Company, 195 Broadway, New York.

Exercise Book for Self Improving Arithmetic, by Thomas T. Goff, Normal School, White Water, Wisconsin. 22.5x27.5 cm. Paper. The MacMillan Company, New York City.

Quantitative Analysis by Stephen Popoff, State University of Iowa. Pages xiii+342. 14x20 cm. Cloth. 1923. $2.25. P. Blakiston's Son & Co., Philadelphia.

BOOK REVIEWS.

Laboratory Chemistry for Girls, by Agnes French Jaques, Head of the Science Department, Vocational High School, Minneapolis. pp. vii+244. 1.75x13x19 cm. Cloth. Line drawings. D. C. Heath & Co. 1923.

This is essentially a bound laboratory manual with frequent references to various texts and with considerable comment and with more or less of general direction along with the specific directions for the performance of experiments. It is designed especially to conform to the interests of women and girls and is adapted to the needs of those who are in training to become nurses as well as to the needs of the more adult "experienced" nurse. It will fit in with the usual courses for girls in vocational schools. The applications of chemistry are stressed rather than the theories or the principles. The chapter headings will show the reader that relatively little space is devoted to the fundamentals of general inorganic chemistry and a relatively large amount is given to organic and applied organic chemistry. The chapter headings follow. I. Elements & Compounds and the Language of Chemistry. II. The gases of the air and some of their useful compounds. III. Water for drinking and cleaning and its mineral content. IV. (82 pp are devoted to the preceding subjects) IV. Carbon, Its Fuel Compounds and other Organic Compounds. (26 pp) V. Acids, Alkalies, Salts, and their action on Metals and Fabrics. (25 pp) VI. Sugars and Starches. 14 pp. VII. Fats Soap Making and Cleaning. 17 pp. VIII. Protein Foods. 22 pp. IX. The action of the Saliva. 9 pp. X. The action of the gastric juice. 7 pp. XI. The action of the juices of the intestine. 12 pp. XII. Urine Analysis and Pathologic tests. 21 pp. Appendix. Index.

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In addition to its usefulness in the particular field for which it was intended this manual would be valuable for use by chemistry classes doing project work. This is especially true of the latter part of the book. The directions seem to be especially clear and complete.

F. B. W.

General Chemistry, an Elementary Survey, Emphasizing Industrial Applications of Fundamental Principles, by Horace G. Deming, University of Nebraska. 4x14½x22 cm. xii+605 pp. Cloth. Illustrated. N. Y., John Wiley & Sons. 1923.

This text is designed for college use, either for students who have had High School Chemistry or for those who have not. One of the distinctive features of the book is its segregation of theoretical topics in special chapters. These can thus be used in the order of presentation or deferred until later in the course. For example, beginners who had not had high school chemistry could be given the descriptive material of the first thirteen chapters without being assigned the work on "How chemical formulas are obtained" (Chap. X). Later on this subject could be taken up.

Another feature of the text is its emphasis upon the application of chemistry to the industries. The portions of the book dealing with industrial applications are well written and well illustrated.

The organic sections too are of more generous scope than is usual in a general chemistry and there are chapters on colloid chemistry and on the chemistry of nutrition. Radio activity, the modern version of the periodic law with atomic number, atomic sub-structure, isotopes, etc., are briefly but adequately treated. Chemical calculations are especially well taught. An excellent appendix furnishes many tables, a brief history of chemistry and a brief bibliography.

This text should be considered by all college teachers of chemistry, for it appears to have been well modernized without having been made too difficult for the earnest student of chemistry. The trifler in college will not fare well with it, but neither will he fare well on any kind of text.

F. B. W.

Chemical Calculations, by R. Harmon Ashley, Ph. D., Professor of Chemistry, Tufts College Premedical and Dental School. Pp. ix+527. 2.5x13.5x20 cm. Illustrated with several graphs. Cloth. Price $3 net. Third edition. 1923. D. Van Nostrand Co., N. Y.

A new edition of a book which has been much used. In the revision the author has entirely rewritten Chap. II on Approximate numbers. The system of notation by the powers of ten, for which so much use is now had in connection with expressing very small weights and very large numbers, is clearly explained and the connection between this system and the finding of characteristics of logarithms is pointed out. The content of the book is indicated by the chapter headings which follow. I. Ratios, II. Approximate numbers, III. Interpolation, IV. Heat, V. Specific Gravity, VI. Gas Calculations, VII. Calculation of Atomic Weights and Formulas, VIII. Gravimetric Analysis, IX. Volumetric Analysis, X. Use of Specific Gravity Tables and Acid Calculations.

Hundreds of problems are furnished, answers being provided, and these answers are given in connection with the problem instead of being relegated to the back of the book. The author says to those who might object that some students will work for answers, that such students would even look them up if they were in the back of the book.

F. B. W.

Elementary Organic Chemistry, by W. H. Barrett, M. A., Assistant Master at Harrow School; Late Williams Exhibitioner of Balliol College, Oxford. 13x19x1.5 cm. Cloth. 1922. Oxford, at The Clarendon Press, Oxford University Press, American Branch, New York, $1.50.

This is a condensed treatise on the essentials of organic chemistry with accompanying laboratory manual of 66 experiments interspersed with the text. It resulted from a series of lectures given to candidates for scholarships at the universities. It gives in excellent fashion most of the essentials of elementary organic chemistry and wisely omits much material in order that that which is given may be well handled. Fundamental concepts and general behavior of classes of substances and generally useful methods of preparation are stressed. Much space is given to presenting the kind of data and the methods of reasoning by which we arrive at conclusions regarding formulae. The treatment of structural formulae and sterio chemistry is excellent. In order that the reader may note the content and order of presentation the chapter headings are appended. 1-Organic analysis, 2-The Paraffins, 3-The Alkyl Halides, 4-The Alcohols, 5-Oxidation of the Alcohols, 6-The Ethers, 7-Aldehydes and Ketones, 8-The Fatty Acids, 9-The Derivatives of the Fatty Acids, 10-The Alkyl Amines, 11-The Nitro Paraffins, 12-The Nitriles and Isocyanides, 13-The Unsaturated Hydrocarbons, 14-The Olefines or Alkylenes, 15-Acetylene, 16-The Aromatic Hydrocarbons, 17-The Sulphonic Acids, 18-Aromatic Nitro Compounds, 19-Aromatic Amines, 20-Aromatic Diazo Compounds, 21-The Phenols, 22-Aromatic Halogen Compounds, 23-Aromatic Alcohols and Aldehydes, 24-Aromatic Acids, 25-Steriochemistry, 26-Polysubstitution Products of the Paraffins, 27-The Carohydrates, 28-Unsaturated Compounds, 29-General Methods of Synthesis and Analysis. Index.

F. B. W.

Chemistry in Every Day Life, by Charles G. Cook, Ph. D., of the Boys' High School, New York City. With included laboratory manual. pp. viii+454. Cloth. 1923 edition. Illustrated. New York. D. Appleton & Co. 2.5x13.5x19 cm.

This is a new edition of a book which has been well known for some time. Its plan is somewhat different from the usual high school text in that the discussion of theoretical matters is reserved for the 25th chapter, which is the last chapter. A glance at this last chapter shows that, as the walrus said "the time has come . . . to mention many things." The pupil who was about to complete his study of the subject matter of the 24th chapter would doubtless be in the same frame of mind as was Gay-Lussac when he said that "the time is not far distant when we may submit to calculation most chemical phenomena."

It should of course be said that the avowed purpose of the text, as its title implies, is to consider the relations of chemistry to "everyday life" so, as the author says in the first sentence of chapter 25, "In the preceding chapters we have given our time mostly to the study of chemical facts discovered by the chemists of the past and to the descriptions of processes and applications of chemical knowledge."

The teaching of the theory, when once it is arrived at, is excellent, although extremely compact. As equations are used throughout most of the text an account of the conventional symbols, formulae and equations is given in chapter 7 but no weight basis seems to have been given. Valence is also taught very early.

The industrial applications of chemistry are, naturally, well handled and the illustrations are excellent. Those teachers who are so situated or so inclined that they are to teach chemistry with the major stress on its applications will do well to give this text careful study.

F. B. W.